



ADMINISTRATION REPORTS OF
**THE AGRICULTURAL CHEMIST
ENTOMOLOGIST AND
MYCOLOGIST**

OF THE
DEPARTMENT OF AGRICULTURE, MADRAS
(DETAILED REPORT)
1938-39



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CONTENTS

	PAGE
1. Administration Report of the Government Agricultural Chemist	1
2. Administration Report of the Government Entomologist	30
3. Administration Report of the Government Mycologist.	50

ADMINISTRATION REPORT AND DETAILED SCIENTIFIC REPORT OF THE GOVERNMENT AGRICULTURAL CHEMIST FOR THE YEAR 1938-39.

I submit herewith the detailed report of my section for the year 1938-39.

1. I was in charge of the section throughout the year.

2. *Amalgamation of teaching and research.*—As per orders in G.O. No. 1704, Development, dated the 14th July 1938, the teaching of chemistry to the students of the Degree course was put under my control and the teaching staff transferred to my section. This took effect on 1st August 1938. Sri H. Shiva Rao, Lecturer in Chemistry, was designated Assistant Agricultural Chemist, and continued to be in charge of the Teaching branch.

3. The work of the section is reported on under three sub-heads: (i) general, including analytical and advisory work; (ii) teaching to students of the Degree course and (iii) research in Soil Science, Plant and Animal Nutrition, Microbiology and Agricultural industry.

I. GENERAL.

Meteorology.—Records of the climatological conditions at 8:00 hours were maintained. A monthly weather review compiled from reports received from the agricultural research stations and from extracts from the Indian Daily Weather Reports published at Poona was published in the *Madras Agricultural Journal*.

Table below gives a summary of observations recorded at the Agricultural Research Institute for the year 1938-39:—

TABLE I.
Annual Weather Report, 1938-39.

Year and month.		Temperature.					
		Absolute maximum.	Absolute minimum.	Mean maximum.	Departure from normal.	Mean minimum.	Departure from normal.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
1938 -							
April	98.0	69.5	95.0	- 0.6	73.5	+ 0.4	
May	97.8	71.5	95.8	+ 0.8	74.5	+ 0.5	
June	92.2	68.0	88.0	+ 1.0	72.9	- 0.2	
July	91.2	68.5	86.5	Nil	68.9	- 3.4	
August	92.0	68.3	88.2	+ 1.3	71.1	Nil	
September	92.0	65.0	88.6	- 0.9	69.5	- 1.0	
October	90.0	60.7	88.4	+ 0.9	69.1	- 1.3	
November	92.2	58.5	86.8	+ 2.3	66.2	- 2.3	
December	88.0	58.7	84.8	+ 1.0	65.7	+ 0.6	
1939 -							
January	88.0	56.9	84.3	- 1.6	62.9	- 1.3	
February	93.0	56.8	89.8	- 0.7	64.8	- 1.0	
March	99.0	59.5	95.3	+ 0.5	67.2	- 2.5	

Annual Weather Report, 1938-39—cont.

Year and month.	Humidity.		Wind Velocity.		Rainfall in inches.		Number of rainy days.
	Humidity at 8 hours.	Departure from normal.	Mean for the month in M. P.H.	Departure from normal.	Actual for the month.	Departure from normal.	
	(8)	(9)	(10)	(11)	(12)	(13)	
1938—							
April	72.4	+ 1.3	1.1	- 1.5	2.17	- 0.3	6
May	61.7	- 8.5	3.2	- 0.3	0.20	- 2.4	2
June	68.5	- 1.0	6.2	- 1.2	0.48	- 1.0	4
July	68.5	- 3.4	5.2	- 3.4	1.57	- 0.5	9
August	74.0	Nil.	3.0	- 4.0	2.16	+ 1.0	4
September	81.2	+ 7.7	3.0	- 2.3	1.65	- 0.1	4
October	72.0	- 7.9	3.0	+ 0.2	3.02	- 2.7	4
November	72.4	- 8.2	1.5	- 0.7	1.21	- 3.6	2
December	78.9	+ 0.1	2.3	- 0.7	0.74	- 0.8	2
1939—							
January	77.0	+ 0.8	2.8	- 0.2	2.14	+ 1.4	2
February	65.7	- 6.2	3.5	+ 0.7	Nil.	- 0.5	Nil.
March	60.8	- 8.9	2.6	+ 0.1	0.48	- 0.3	1

Rainfall.

April to May	2.37
June to September	5.86
September to December	4.97
January to March	2.62

Total .. 15.82

Total rainfall for the year	15.82
Mean based on previous 25 years	25.04
Departure from normal	- 9.22

Rainfall was once more in large defect, the most remarkable feature being that it was in large defect in nearly all the twelve months and most markedly so during the north-east monsoon period. For the whole year rainfall was below normal, by 9.22 inches or about 36 per cent. Day temperatures were generally above normal and night temperatures below normal, a condition associated with drier weather than usual.

Analytical and advisory.—Table II is a statement of the number of samples, the kind of samples and source, from which they were received and analysed during the year.

TABLE II.

Particulars.	Research.	Agricultural department.	Other Government departments.	Ryots and private parties.	United Planters' Association of Southern India.	Total.
Soils	264	161	15	9	..	449
Manures	60	28	..	17	3	108
Waters	30	9	8	2	..	49
Foods and fodders	226	20	159	1	..	406
Cane juices	1	1,297	..	..	..	1,298
Field experiments	4	..	..	..	..	4
Miscellaneous	3	136	..	..	1	140
Total for 1938-39	588	1,651	182	29	4	2,454
Total for 1937-38	560	1,722	225	28	9	2,544
Total for 1936-37	177	1,59	134	34	10	1,834
Total for 1935-36	258	853	140	12	26	1,289

A sum of Rs. 231-8-0 was received as analytical fees, comprising Rs. 13-8-0 from the members of the United Planters'

Association of Southern India, and Rs. 218 from ryots and other private parties. The corresponding amounts for 1937-38 being Rs. 360-8-0 and for 1936-37, Rs. 579-8-0.

As was usual in previous years, the section in addition to doing analysis and sending reports of a routine nature, had to deal with numerous enquiries for advice on matters connected with soils, manures, cattlefeeds and human foods, from officers of the department in connexion with their work, and from officers of other Government Departments, i.e., the Industries, Jail, Public Works and Medical departments.

Of the samples analysed, the following is a summary of samples of interest:—

- (1) The Madura District Paddy Sales Society has taken a lease of the night-soil and municipal rubbish from the Madura Municipality and has been making trials at preparing compost (poudrette) using the above materials by the Indore process at the municipal depot at Karuppayurani, a village a few miles off Madura town, adopting the ratio of 1 of night-soil to 3 of municipal rubbish. The resulting compost was an average sample and had the following composition, on dry basis:—

	PER CENT.
Nitrogen (N)	0.55
Phosphoric acid (P_2O_5)	0.82
Potash (K_2O)	0.90
Humus	1.50

It was found however that the cost of production was somewhat prohibitive and came to Rs. 2-0-6 per cart-load of manure, when the cattle manure was available at Re. 1-2-0 for the same quantity. It was naturally felt that they were not offering the ryot an attractive proposition in advising them to purchase their compost, especially in view of the fact that their compost was just equal in manurial value to the farm-yard manure. Advice was sought for to bring down the cost of production. The departmental system as detailed in Leaflet No. 67 was suggested for adoption and the proportion of rubbish was increased to four. The resulting compost had the following composition, on dry basis:—

	PER CENT.
Nitrogen (N)	0.40
Phosphoric acid (P_2O_5)	1.00
Potash (K_2O)	0.98
Humus	2.48

This was in no way inferior to the other one. The new method had the further advantage of yielding a larger quantity of manure which should naturally lessen the cost of manure per cart-load.

- (2) At the instance of the Assistant Director of Agriculture, Kurnool, a sample of sunnhemp seed was analysed for its feeding value, with the following results:—

Heads of analysis.				PER CENT.
Moisture	..	..	..	9.18
Ash	..	..	..	5.49
Crude proteins	..	..	..	37.16
Ether extractives	..	..	..	5.00
Crude fire	..	..	..	7.02
Carbohydrates (by difference)	..	..	..	36.15
Total				100.00

Albuminoids	..	..	..	35.68
Lime (CaO)	..	..	..	0.11
Phosphoric acid (P_2O_5)	..	..	..	1.02
Acid value	..	..	..	8.77

The seeds are rich in proteins and contain fair amounts of phosphoric acid and lime and can be very well used as cattle-food.

- (3) A sample of fish meal was analysed for Mr. K. Abdulkader Bava of Mangalore and had the following composition:—

				PER CENT.
Moisture	..	..	..	15.07
Loss on ignition	..	..	..	56.31
Insoluble mineral matter	..	..	..	2.03
Nitrogen (N)	..	..	..	8.17
Phosphoric acid (P_2O_5)	..	..	..	4.43

The sample was very moist, containing as much as 15.0 per cent of water; otherwise it was a good sample of fish manure.

- (4) The Assistant Director of Agriculture, Nellore, sent three samples of tobacco parts, for the estimation of their manurial value as these were reported to be largely used for manurial purposes round about Guntur. As would be seen from their analytical data given below, these contained good amounts of plant food ingredients. The stems gave the maximum amounts of potash while the buds excelled in their nitrogen content. Phosphoric acid was rather low and was present in equal amounts in all the three parts. Such material would be useful in making of compost with other waste material.

On dry basis.

Heads of analysis.	Tobacco samples.		
	Virginia flue cured scraps.	Virginia stems.	Country tobacco.
	PER CENT.	PER CENT.	PER CENT.
Ash	34.52	27.13	15.24
Nitrogen, (N)	1.52	1.55	2.31
Potash (K_2O)	4.30	8.61	4.99
Phosphoric acid (P_2O_5)	0.49	0.42	0.44

- (5) A sample of fodder grass—*Leptochloa obtusiflora*, Hochst—was examined for the presence of hydrocyanic acid and also for its feeding value, at the instance of the Principal, Agricultural College, Coimbatore. The grass had an average feeding value as would be evident from the following values :—

					PER CENT.
Water	..	..	..	..	58.7
Ash	..	..	..	..	5.7
Crude proteins	..	..	..	..	4.9
Ether Extractives	..	..	..	..	1.0
Crude fibre	..	..	..	..	13.5
Carbohydrates (by difference)	..	..	..	..	16.2
Total					100.0
Albuminoids	..	..	..	..	3.4

Unfortunately, the sample contained small amounts of hydrocyanic acid—(0.0064 per cent) thus rendering it unfit for fodder purposes. It was further examined for the presence of HCN at different stages of its growth, namely, (i) before flowering, (ii) spikes just emerging and (iii) spikes soon after fertilization. The hydrocyanic acid was found to be present at all these three stages.

- (6) A sample of weed, identified by the Systematic Botanist as *Croton Sparsiflorous*, Morong and reported to be a way-side weed introduced into this country in recent years from South America, was analysed for its manurial value. This contained good amounts of nitrogen and potash and might do well for green manure purposes, but considering the woody nature of the stems of the plant, it was better to have this composted before using as manure. To all appearance this looks like the chilly plant and is locally named as "Vinai poondu" or "Molagai poondu." The analytical data are given below :—

					PER CENT.
Water	..	..	..	..	8.42
Nitrogen (N)	..	..	..	..	2.32
Potash (K ₂ O)	..	..	..	..	3.71
Phosphoric acid (P ₂ O ₅)	..	..	..	..	0.38

- (7) At the instance of the Assistant Lecturer in Botany, another introduced weed—belonging to the family comferita—*Tridax Procumbens*, L.—was analysed for its feeding value and mineral contents. The weed contained good amounts of food ingredients but the fibre content is a bit high and it is particularly rich in its lime content. It is said that buffaloes have a special liking to this.

Its analysis is as follows:—

Heads of analysis.	Tridax Procumbens L.	
	On dry basis.	On original moisture basis.
	PER CENT.	PER CENT.
Moisture	..	81.11
Ash	23.16	4.38
Crude proteins	9.97	1.88
Ether Extractives	3.15	0.59
Crude fibre	29.83	5.64
Carbohydrates (by difference).	33.89	6.40
Total	100.00	100.00
Albuminoids	8.13	1.54
Insoluble mineral matter	8.35	1.58
Iron (Fe_2O_3)	0.85	0.16
Alumina (Al_2O_3)	1.00	0.19
Lime (CaO)	4.80	0.91
Magnesia (MgO)	Traces.	Traces.
Potash (K_2O)	3.76	0.71
Phosphoric acid (P_2O_5)	0.68	0.13
Nitrogen (N)	1.60	0.30

(8) The Farm Manager, Agricultural Research Station, Nandyal, sent two samples of farm-yard manure for analysis and report. One of these was prepared at the farm and the other one by a ryot in the neighbourhood of the farm. It will be noticed from the analysis given below that, in the sample from the neighbouring ryot, there has been a good deal of loss of nitrogen and that the sample of farm-yard manure from the farm is but an average sample.

Farm-yard manures.

Heads of analysis.	Prepared at the Agricultural Research Station, Nandyal.		Prepared by a neigh- bouring ryot.	
	On original moisture basis.	On dry basis.	On original moisture basis.	On dry basis.
	PER CENT.	PER CENT.	PER CENT.	PER CENT.
Moisture	28.46	..	61.04	..
Loss on ignition	13.18	18.43	21.73	55.80
Insoluble mineral matter	40.90	57.17	11.02	28.30
Solubles (by difference)	17.46	24.40	6.21	15.90
Total	100.00	100.00	100.00	100.00
Nitrogen (N)	0.32	0.45	0.07	0.18
Potash (K_2O)	0.73	1.02	0.52	1.33
Phosphoric acid (P_2O_5)	0.28	0.39	0.23	0.59
Humus	1.95	2.73	3.97	10.19

In the outside sample, there was however a larger amount of organic matter and humus.

- (9) An attempt was made at the Agricultural Research Station, Palur, to harvest the groundnut crop A.H. 125, by a new method under the direction of the Assistant Director of Agriculture, Cuddalore, which was expected to give a better quality of kernels for oil and haulms for feeding cattle. The new method was to dry the pods and haulms, by a certain arrangement, even if wet weather prevailed, so that the haulms and pods might not be allowed to ferment. As soon as the plants were pulled out with the pods they were cured on racks arranged in the form of a gable. Here it remained for some weeks being well protected from rains. By the ordinary method, in vogue, the plants were pulled out and pods picked out on the same day. The haulms would dry on the field itself. During rains or cloudy weather, either the haulms got wet or the pods and the haulms did not dry in time. The samples of haulms collected by these two methods were analysed for their feeding values and the pods for their oil content and the results are given below:—

Heads of analysis.		New method of harvest.	Ordinary method of harvest.
		PER CENT.	PER CENT.
Haulms—			
Moisture	.. ..	8.07	8.67
Ash	.. ..	7.86	12.09
Crude proteins	.. ..	7.85	9.80
Ether Extractives	.. ..	0.99	0.81
Crude fibre	.. ..	36.93	39.01
Carbohydrates (by difference).		38.30	29.62
Total		100.00	100.00
Insoluble mineral matter	.. ..	2.49	5.00
Albuminoids	.. ..	6.50	7.61
Acid value (mgm of KOH per gram of ether extractives).		119.8	113.2
Pods—			
Ether Extractives	.. ..	52.79	52.43
Percentage of nuts to whole pods	.. ..	66.50	71.50

The ordinary method would appear to have given the better results, in more than one respect. The percentage of nuts to the whole pods is greater, and the feeding value, in general, is superior.

II. TEACHING.

Degree course.—With the change in the control of the teaching of Agricultural Chemistry from 1st August 1938, the entire staff was transferred to this section. Table below gives the number of lecture classes and practical classes for the three classes of the Degree course during the academic year 1938-39 :—

TABLE.

Details of lectures and practical classes for the academic year 1938-39.

	Class.			Lecture classes.	Practical classes.	Special lectures.
Class I	..	..	..	65	63	4
Class II	..	..	..	56	55	..
Class III	..	..	..	143	73	..
Total				264	191	4

The lecture classes were each of one-hour duration while the 191 practical classes had a total duration of 382 hours.

The special lectures were delivered by members of the staff on subjects in which they were working and were delivered at the end of the academic year to the senior students of the B.Sc. Ag. Degree class with the object of acquainting them with the progress of work in the subjects dealt with.

The deputation of staff engaged exclusively on research for teaching of subjects on which they are working was started at the beginning of the academic year 1939-40 which begins on 15th June when the classes II and III reassembled after their vacation. Sri C. Raghavendrachar was deputed for teaching Geology in relation to soil formation to students of the B.Sc., class III, and other assistants will be deputed for such work during the year.

Short course on malt-making.—A course of lectures and practical work covering a period of fifteen days in the month of September was undertaken for students of the short course. Nine students attended the course.

Ten lectures were given and practical classes conducted to give the students a working knowledge of the process of malt-making from cholan and other cereals.

Short course on jaggery-making.—A short course on jaggery-making consisting of lectures and practical classes was conducted by this section in the month of February 1939. The number of

students who attended the course was thirteen. They were given a series of eleven lectures on the chemistry of jaggery-making and practical demonstration to enable them to take up the method as their own.

III. RESEARCH.

Reclamation of alkaline soils in the high level channel area in the Kulittalai taluk.—The work reported on in the last year's report (1937-38) was continued and a detailed report submitted in May 1939 (vide R.O.C. No. 304/39, dated 30th May 1939) in which details were given of the work done and results achieved, and other recommendations made. The work has been programmed to continue for another year (fasli 1939-40).

The experiments conducted during the year under report were (i) in the field at Mettumarudur village, one of the worst affected areas, and (ii) in pots at Coimbatore with soil brought from the Mettumarudur village.

Field experiments.—These experiments were started in 1937 in an area placed at our disposal by Sri K. V. Srinivasa Ayyangar, a mirasidar of the area. The plots laid out were ten in number of which two were treated with sulphur at 1 ton per acre, two with sulphur at 2 tons per acre, and two plots with gypsum at 10 tons per acre, two plots left as control with flooding and draining and two retained in their original condition. The area selected was about the worst affected being a newly reclaimed one, it was devoid of any vegetation except a few palmyra trees not even grass grew on the lands in question. Each plot measured 7.5 cents and was drained by a drainage channel from its neighbourhood and the whole experimental area was drained into the natural drainage of the block of land, the Valiapatti vari which ultimately drains into the Kulittalai katuvvari. The sulphur treated plots were treated in October 1937 and the gypsum plots in January 1938. Soils were sampled in March 1938 and were reported on in last year's report.

A green manure crop Dhaincha was sown on all the plots in July 1938. Germination was good in the gypsum treated plots, fair in the sulphur plots and nil in the control plots. The quantity of leaf available being inadequate, sufficient leaf was added at 500 lb. per each plot and ploughed in.

Paddy-seedlings (Sadai samba) were transplanted towards the last week of October 1938. By the beginning of December the seedlings in the control plots had completely withered away while in plots 1-5 vigorous growth was seen. The crop was harvested early in February 1939. The yields from plots 1-5 (gypsum and sulphur treated) average 1,050 lb. grain and 1,450 lb. straw per acre while the rest had no crop on them. This yield is about the average for the whole area under paddy when owing to unfavourable condition the crop was generally below normal.

It will be seen that, as compared among themselves, the data, show a high salt content, high pH and high exchangeable sodium and potassium for the control plots 7-10, and a markedly lower value for the plots 1-6, treated with gypsum and sulphur. This can be said to account for the fact that while no crop growth was possible in the control plots, an average crop of paddy could be raised on the treated plots.

Considering that the lands in question were barren areas on which no plant growth was possible because of a high pH and high salt content, it is gratifying to note that a crop of paddy approximating an average crop for the area was raised within an year of taking up ameliorative treatment.

Similar treatment can be adopted for the rest of the area now lying barren, but it must be emphasized that the treatment, given to the soil, should be followed up by inducing good drainage in the whole area.

The soil ameliorants used were gypsum at 10 tons and sulphur at 1 and 2 tons per acre. Sulphur costs at present anything up to Rs. 150 to Rs. 200 per ton depending on fineness of grinding, which makes its use prohibitive, ranging from Rs. 300 to Rs. 400 per acre. Gypsum at 10 tons per acre would cost only Rs. 100 and is available in abundance in the Perambalur taluk of Trichinopoly district in the near vicinity of the affected area.

In the course of the investigation it was seen that paddy was an excellent reclamation crop, by reason of its habit of living under flooded condition approaching that of a swamp. Any soil ameliorant is added to react on the sodium clay in the soil and by introducing the calcium ions coupled with sulphate to induce the formation of a calcium clay with the sodium in sulphate form. The flooding with drainage is designed to remove the soluble Na_2SO_4 in the drainage water.

According to the laws of mass action, unless the product of reaction is capable of being speedily removed, the reaction is not capable of moving forwards. In the experiments the speedy removal of sodium sulphate in the drainage waters facilitated the action of the calcium sulphate. One marked effect was that the soils in the gypsum plots were much more permeable and well drained internally.

The work will be followed up during the year 1939-40 and a further crop of green manure grown and ploughed in and another crop of paddy raised.

Reclamation of alkaline soils in Field No. 77—Central Farm, Coimbatore.—It was reported that Field No. 77 in the Central Farm was alkaline and no crop came up satisfactorily, except ragi which is usually a salt tolerant crop. This field was taken up for a study of reclamation with sulphur and molasses. Soil samples were taken before any treatment was given and showed a high pH and high salt content chiefly as carbonates and bicarbonates. Thirty

plots were laid out with treatment of (i) sulphur at $\frac{1}{2}$ ton per acre, (ii) sulphur at 1 ton per acre, (iii) molasses at 4 tons and (iv) molasses at 8 tons per acre and (v) control, there being six replication of each of the five treatments.

Samples were collected at intervals of one month and analysed for the carbonate and bicarbonate content, total salts and pH.

It was seen that at the end of the third month the pH and carbonate and bicarbonate content had decreased appreciably in the sulphur treatment while with molasses no significant decrease could be noted. A crop of Chitrai cholam was sown in all plots in March. The crop was not quite normal owing to its being the first one after soil amendments had been added. Work is in progress.

Studies on the black soils of Madras Deccan—(a) Profile studies.—The investigation reported on last year was continued. Previous work has shown that the black soils of the Madras Deccan, and occupying a large area, were a distinct type by themselves in physical and chemical properties. They are all clay soils with a high content of calcium and magnesium and with a high soda content at nearly all horizons, the soda content increasing with depth; the clay fraction after isolation was seen to have a high silica—sesquioxide molar ratio of 3 and above which sharply differentiated them from the clay fractions of the red and mixed soils.

This study had led to the formation of a hypothesis that these black soils are formed from specific type of rock, rich in the soda lime feldspars which on weathering have formed soils with a high content of lime and magnesia and also sodium. The black soils are of widespread occurrence, mainly in the central zone of the peninsula of India. The black soils of the Bellary district extend into Hyderabad and into the Bombay Deccan and finally into the Central Provinces. In appearance these soils are all alike, and confer on the country they cover a topography which is very characteristic, with undulations intersected by water courses. The geology of this extensive area is not however similar while the Madras Deccan area and parts of the Hyderabad state contain rock of the granite complex, the rest of the area occupied by the black soil is made up of Deccan trap. The black soils are therefore derived from more than one type of rock. In the Kurnool district the Kurnool Cuddapah formation also gives rise to the black soils.

The study of the black soils from other tracts was taken up during the year, and soils from Nagpur in the Central Provinces were studied. Samples of soil from cultivated and uncultivated area were obtained by the courtesy of the Agricultural Chemist to the Government of Central Provinces. The samples sent represented the profile, foot by foot, down to five feet.

The soils were studied for their mechanical composition, pH, and the composition of the clay fraction separating out in 16 hours, 48 hours and 168 hours.

The soils were found to be heavy clay soils with a high content of fine fractions tending to increase with depth, their pH ranged between 8.5 and 8.8. The soluble salt content was low being about 0.05 per cent at all depths. The soils did not have an increasing salt content with depth. Mechanically the soils were very similar to those of the Bellary area. In pH, they also had a marked similarity, but, in having no salt profile, they differed markedly from those of the Bellary area. This was probably due to the very much heavier rainfall of Nagpur than that of the Bellary area. Nagpur gets an average full of 50 inches per annum while the average for the Bellary district is only about 20 inches. The heavier rainfall has apparently washed out much of the salt from the soil whereas in the Bellary soils the low rainfall has tended to wash them down to the lower layers. The analysis of the clay fraction also reveals very great similarity with that of the Bellary soils, the only difference being that the iron content is appreciably higher and the silica sesquioxide ratio lower in the Central Provinces soils when compared with the Bellary soils.

It would seem that the Deccan trap, from which the Central Provinces soils have been formed, while it is in the main rich in the soda lime felspar, is less silicious and with a higher iron content owing to the presence of ferro magnesian minerals (Hornblende). Though the Bellary soils have been formed from granite and those of the Central Provinces from Deccan trap, rocks of different types and ages, the two soils exhibit a marked similarity owing to the similarity in their minerological composition.

(b) *Studies in the organic matter.*—A preliminary study of the organic matter present in the black soil was started during the year. The distribution of total carbon content, organic and mineral carbon, was under study. Analytical methods were examined for a more detailed study of the problem and minor modifications were made. Type samples, dry black soil and red and irrigated black soil profiles were examined for total carbon, organic and mineral carbon, organic carbon representing humus organic matter and mineral carbon, that fraction of carbon in combination with basic ions as carbonates.

The results of the preliminary investigation were interesting—

(i) The C/N ratio of dry black soil was high being in the neighbourhood of 25 in the upper strata and decreasing with depth. In the irrigated black soils the depth distribution was inverted, i.e., being about 10 at the top and 24 about the middle zone two—three feet below the surface; in the red soil the ratio was low being below 10 at all horizons.

(ii) The organic nitrogen content of the black soil is very low, and the carbonate content high, the organic carbon is mostly concentrated at the surface.

(iii) The nitrogen content is also very low and also concentrated at the surface. The low values for organic carbon and nitrogen contents of the black soils raise the bigger question of

how this can be remedied. In the area which it at present dry and growing one crop per year the problem is serious enough, with the advent of the Tungabhadra project, the question of improving the organic matter content to improve crop bearing capacity and soil texture is still more serious and has to be studied in detail. Work is in progress on the growing of green manure crops and ploughing them under and the effect of such treatment on the organic matter status of the soils.

Field experiments—(a) *Permanent manurial experiments*—(i) *The old permanent manurial experiments*.—No crop has been raised in these experiments for want of irrigation facilities and the plots were left cultivated fallow.

(ii) *The new permanent manurial experiments in Field No. 45 Central Farm*.—In these experiments two crops were taken in the year. Crop No. 22 was ragi, transplanted on 11th—13th of June 1938 and harvested on 26th September 1938 and crop No. 23 was panivaragu, sown on 25th November 1938 and harvested on 16th February 1939. The yields of grain and straw obtained from both the series are given in the statement presented below. The western series received as usual, an application of 2,000 lb. of cattle manure as basal dressing; the effect of this is seen markedly in the case of ragi-crop No. 22, but in the case of the other crop, No. 23, panivaragu, the plots of these series have given lower yields. This crop suffered from white ant trouble, a greater damage was observed in the western series: crop yield was generally low owing to unfavourable season.

New permanent manurials—Yield in pounds per acre.

Plot number.	Crop No. 22. Ragi.				Crop No. 23.			
	Variety.		E C. 593.		Panivaragu.			
	Transplanted 11th/13th June 1938.		Harvested 26th September 1938.		Sown on 25th November 1938.		Harvested on 16th February 1939.	
	Eastern series.		Western series.		Eastern series.		Western series.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
1 No Manure ..	51	511	740	2,397	995	1,293	672	1,145
2 N. ..	434	1,836	1,123	3,903	896	1,244	946	1,468
3 N + K. ..	959	3,980	1,327	4,693	896	1,393	672	1,219
4 N + P. ..	1,760	8,263	2,219	8,493	1,020	1,692	547	1,020
5 N + K. + P. ..	2,219	7,143	2,194	8,520	945	1,941	672	1,443
6 K + P. ..	2,219	5,765	1,683	6,883	796	1,443	647	970
7 K. ..	612	1,887	2,305	5,026	647	821	423	597
8 P. ..	1,786	5,740	1,964	7,729	796	1,020	722	1,393
9 Cattle manure ..	1,939	6,556	2,397	9,080	1,219	2,090	672	1,393
10 Do. (residual) ..	740	2,295	1,556	5,356	622	945	597	846

(b) *Molasses experiments—Residual effect*.—In the wet land B block, a third residual crop was taken this year. The variety was paddy Co. 1. The crop was transplanted on 21st August 1938

and harvested on 11th December 1938. In the table below are given the yields obtained for these four years:—

Yield in pounds per acre.—Paddy CO. 1.

Treatment.	1935-36. Manures applied.		1936-37. Residual 1st year.		1937-38. Residual 2nd year.		1938-39. Residual 3rd year.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
Control ..	1,990	3,455	2,503	3,910	2,896	2,869	2,670	3,043
Five tons molasses	2,770	3,300	2,634	3,586	2,807	2,928	2,719	2,971
Seven and half tons molasses	2,829	3,149	2,475	3,433	2,872	2,778	2,523	2,718
Four tons molasses plus 1 cwt. ammonium sul- phate ..	3,085	3,487	2,468	3,758	2,646	2,632	2,376	2,490

No residual effect of the molasses applied in 1935-36 has been seen in any of these three seasons. The control plot has again given the maximum yield. The results are statistically significant and the experiments have been discontinued now.

(c) *Green manure experiments—Residual effect.*—In the wet lands A block, another residual crop was taken this year also, in the above experiments with paddy. The variety was GEB. 24 as in the previous years. The crop was transplanted on 31st July 1938 and harvested on 5th December 1938. In general the yields obtained were greater than the two previous seasons and the results were not significant. The experiments will be discontinued from now on.

Residual effects—Yields in pounds per acre—Paddy GEB. 24.

Plot number and treatment.	First year. 1935-37.		Second year. 1937-38.		Third year. 1938-39.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	LB.	LB.	LB.	LB.	LB.	LB.
1 Control. (No manure) ..	2,955	3,294	2,739	2,782	3,301	4,044
2 Green manure—2,000 lb.	2,987	3,747	3,003	3,117	3,412	4,226
3 Do. 4,000 "	2,790	3,214	2,835	3,354	3,096	4,580
4 Do. 6,000 "	3,095	3,495	2,877	2,925	3,438	4,769
5 Do. 8,000 "	3,123	3,486	2,893	2,968	3,455	4,426
6 Do. 10,000 "	3,155	3,345	2,484	2,736	3,474	4,629
7 Do. 12,000 "	3,098	3,482	2,691	2,993	3,224	3,847

(d) *Seed-bed manurial experiments.*—In the wet lands (Central farm), a portion of the B. block was relaid into 36 plots for conducting the above experiments and after taking two crops, in the previous two years, without the application of any manure, the various treatments, as per the scheme of experiments given below, were given this year and the first crop of the experiment, with paddy CO. 1. as variety, was taken this season. The yields obtained are given below. Statistically the results have been significant. It is intended to continue these experiments for two more seasons, when it is hoped to arrive at a definite conclusion.

This study was undertaken to examine how far the effect of correct and liberal manuring of the paddy seed-bed will lead to better performance of the seedlings on their being transplanted. Seedlings from a heavily manured seed-bed should normally require

less manure for their development and maturity. The transplant field would then require less manure and thus there might be a saving in the manure bill. A study of this nature had been conducted at the Research Stations, at Berhampore, Aduturai, Maruteru and Pattambi. There were difficulties in comparing the results of these experiments at these several stations since the amount of green leaf applied to the heavily manured seed-beds varied and so also the application of other artificials both in kind and quality. The quantities of green leaf applied have been in the neighbourhood of 20,000 lb. The present experiments have been designed to study the effect of about 4,000 lb. green leaf, at the maximum with and without some quick acting artificials like the ammonium sulphate, and superphosphate. The problem of study is, in the main, one of restricting the manuring of the transplant field to such an extent, that when seedlings from a heavily manured seed-bed are transplanted, the optimum effect may be obtained. Such an investigation will have an economic backing, because, it may be possible, by a judicious manuring of the transplant field, say, cutting the normal application to half or two-thirds, to obtain good yields with seedlings from a heavily manured seed-bed. If it were so, it would be a paying proposition to heavily manure the seed-bed and yet effect a net saving.

The two other points to be considered were (i) the correct dose of manure to be applied to the seed-bed and (ii) the age at which the seedling should be transplanted.

In the manured seed-bed, the seedlings make better progress, than in the unmanured seed-bed. This has the further advantage of hastening planting, since early planting is always beneficial. This season the condition of the seedlings from the three seed-beds, namely—poor, normal and heavily manured—have been fairly uniform and it was possible to have them transplanted on or about the same date. It was, however, observed that the seedlings from the heavily manured seed-bed were more succulent and heavier, as the following data relating to 100 seedlings picked at random from each would indicate :—

	Poor seed-bed.	Normal manured seed-bed.	Heavily manured seed-bed.
Weight of 100 seedlings ..	69 gms.	94 gms.	112 gms.
Moisture, per cent ..	80.0	82.0	85.0

The scheme of experiments adopted was as follows :—

Four randomised blocks of 9 series of treatments made up of 3 kinds of seed-beds and 3 kinds of transplant fields.

Seed-beds.

Nature of seed-bed.	Dosage of manure per acre.		
	Green leaf.	Ammonium sulphate.	Super phosphate.
	LB.	LB.	LB.
Poor ..	2,500	..	..
Normal manured ..	0,000	200	200
Heavily manured ..	20,000	400	300

Transplant fields.

Nature of field manuring.	Dosage of manure per acre.		
	Green leaf.	Ammonium sulphate.	Super phosphate.
	LB.	LB.	LB.
No manure	..	..	..
Half manured	2,000	50	50
Normal manured	4,000	100	100

Thus there were 36 plots—9 series, each replicated four times.

The treatments are as follows:—

- A, Poor seedlings in no manure plot.
- B, Normal seedlings in no manure plot.
- C, Heavily manured seedlings in no manure plot.
- D, Poor seedlings in half manured plot.
- E, Normal seedlings in half manured plot.
- F, Heavily manured seedlings in half manured plot.
- G, Poor seedlings in normally manured plots.
- H, Normal seedlings in normally manured plots.
- K, Heavily manured seedlings in normally manured plots.

Each of the above is replicated four times and the treatments randomized in each block. The results of yields obtained, with other details, are given in the tabular statement below.

Results of yield from seed-bed manurial trials (S.M.T.) in B block, Central Farm, 1938-39.

Area harvested and calculated acre yield 3.75 cents.

Date of transplanting Date of harvest		21-8-1938 11-12-1938		N/2 ' plot normal seedlings.		N/2 ' plot + Poor seedlings.		N ' plot + Normal seedling.		N ' plot + Heavy seedling.																			
Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.																			
Plot.	Grain. (1)	Straw.	Plot.	Grain. (2)	Straw.	Plot.	Grain. (3)	Straw.	Plot.	Grain. (4)	Straw.	Plot.	Grain. (5)	Straw.	Plot.	Grain. (6)	Straw.	Plot.	Grain. (7)	Straw.	Plot.	Grain. (8)	Straw.	Plot.	Grain. (9)	Straw.	Plot.	Grain. (10)	Straw.
A	LB.	LB.	B	LB.	LB.	C	LB.	LB.	D	LB.	LB.	E	LB.	LB.															
3	3,040	3,760	6	2,134	2,294	8	2,800	3,227	5	2,534	3,014	9	3,049	3,814															
10	2,560	3,147	18	2,053	2,213	16	2,453	2,587	11	2,267	2,677	15	3,361	3,867															
26	1,787	2,134	25	1,920	2,187	20	2,107	3,460	22	2,614	3,621	21	3,412	4,320															
29	2,294	2,560	31	2,773	2,880	32	3,201	3,494	33	2,427	3,120	35	1,945	2,240															
Average	2,420	2,900	..	2,220	2,394	..	2,640	3,192	..	2,460	2,980	..	2,939	3,560															
N 1/2 ' plot + heavy seedling.		N ' plot + poor seedlings.		N ' plot + heavy seedling.		N ' plot + Normal seedling.		N ' plot + Heavy seedling.		N ' plot + Normal seedling.		N ' plot + Heavy seedling.		N ' plot + Normal seedling.		N ' plot + Heavy seedling.		N ' plot + Normal seedling.		N ' plot + Heavy seedling.		N ' plot + Normal seedling.		N ' plot + Heavy seedling.		N ' plot + Normal seedling.		N ' plot + Heavy seedling.	
Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.		Per acre.	
Plot.	Grain. (11)	Straw.	Plot.	Grain. (12)	Straw.	Plot.	Grain. (13)	Straw.	Plot.	Grain. (14)	Straw.	Plot.	Grain. (15)	Straw.	Plot.	Grain. (16)	Straw.	Plot.	Grain. (17)	Straw.	Plot.	Grain. (18)	Straw.	Plot.	Grain. (19)	Straw.	Plot.	Grain. (20)	Straw.
F	LB.	LB.	G	LB.	LB.	H	LB.	LB.	I	LB.	LB.	J	LB.	LB.	K	LB.	LB.	L	LB.	LB.	M	LB.	LB.	N	LB.	LB.	O	LB.	LB.
2	3,760	5,014	4	2,934	3,626	7	2,693	3,120	1	4,027	5,200	1	4,027	5,200	1	4,027	5,200	1	4,027	5,200	1	4,027	5,200	1	4,027	5,200	1	4,027	5,200
13	2,907	3,430	17	2,400	2,347	12	3,254	3,707	14	3,460	3,760	14	3,460	3,760	14	3,460	3,760	14	3,460	3,760	14	3,460	3,760	14	3,460	3,760	14	3,460	3,760
27	2,720	3,334	19	2,614	3,867	23	2,720	3,201	24	2,480	3,307	24	2,480	3,307	24	2,480	3,307	24	2,480	3,307	24	2,480	3,307	24	2,480	3,307	24	2,480	3,307
28	3,787	4,427	34	2,934	3,173	36	2,880	3,094	30	3,466	4,027	30	3,466	4,027	30	3,466	4,027	30	3,466	4,027	30	3,466	4,027	30	3,466	4,027	30	3,466	4,027
Average	3,294	4,651	..	2,720	3,253	..	3,253	3,289	..	2,887	3,358	..	3,358	4,073	..	3,358	4,073	..	3,358	4,073	..	3,358	4,073	..	3,358	4,073	..	3,358	4,073

Nursery area.

Per acre.	
Grain.	Straw.
..	6,300
..	5,000
..	2,848

Effect of effluent water on paddy.—This experiment was repeated this year also, but results were not significant.

Plant nutrition—Analysis of potato varieties.—At the instance of the Director of Agriculture, Madras, the detailed chemical analysis of the important potato varieties being grown at the Agricultural Research Station, Nanjanad, and recommended to ryot in the Nilgiris district was taken up. The varieties selected were (i) Great Scot, (ii) Royal Kidney, (iii) Divernon, (iv) Ben Cruchan, (v) Bishop, (vi) Catriona, (vii) President, (viii) Talisman, (ix) King Edward, (x) Golden wonder, (xi) Kerr's pink. The potato crosses being only in the first year of trial were not taken up for analysis. A sample was obtained from the local market, and was also analysed for purposes of comparison.

The three first named are early maturing varieties, matured in $3\frac{1}{2}$ months, the other 8 varieties take $4\frac{1}{2}$ months to come to harvest. The variety Great Scot commands wide market because of its reputation for good keeping quality, size and colour.

The chemical composition of the varieties analysed is given below.

Food and mineral values relating to potato tubers from the Agricultural Research Station, Nanjanad, on dry basis.

	Short duration varieties.			Long duration.		
	Great Scot.	Royal Kidney.	Divernon.	Ben Cruchan.	Bishop.	Catriona.
	(1)	(2)	(3)	(4)	(5)	(6)
	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.
Crude proteins	11.68	10.94	11.85	8.13	9.84	11.61
Ash	4.48	4.20	3.83	3.98	4.07	4.11
Ether Extractives	0.25	0.20	0.36	0.60	0.86	0.80
Crude Fibre	2.93	2.96	2.36	2.70	2.59	2.50
Starch and other carbohydrates by difference.	80.66	81.70	81.55	84.59	82.64	80.98
Total ..	100.00	100.00	100.00	100.00	100.00	100.00
Lime (Ca O)	0.14	0.11	0.10	0.17	0.10	0.14
Potash (K ₂ O)	2.29	2.23	1.98	2.01	2.11	2.05
Phosphoric acid (P ₂ O ₅)	0.68	0.60	0.47	0.43	0.95	0.63
Original moisture	78.36	78.95	78.10	78.02	76.61	77.99
	Varieties.					Non-descriptive local variety.
	President.	Talisman.	King Edward.	Golden Wonder.	Kerr's pink.	
	(7)	(8)	(9)	(10)	(11)	
	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.
Crude proteins	8.06	9.14	8.53	8.51	8.47	7.16
Ash	3.59	3.57	3.72	3.90	3.82	4.54
Ether Extractives	1.12	0.96	0.23	0.28	0.29	0.90
Crude Fibre	2.08	2.27	2.85	2.86	2.57	4.30
Starch and other carbohydrates by difference.	85.15	84.06	81.67	84.45	84.85	83.10
Total ..	100.00	100.00	100.00	100.00	100.00	100.00
Lime (CaO)	0.14	0.16	0.13	0.10	0.08	0.17
Potash (K ₂ O)	1.66	1.61	1.60	1.93	1.89	2.04
Phosphoric acid (P ₂ O ₅)	0.39	0.47	0.48	0.53	0.49	0.43
Original moisture	74.89	75.72	76.77	73.22	74.86	76.34

It will be seen that the variety Great Scot has analysed the best both as regards nitrogen content and potash content. Next in quality comes Royal Kidney. Both these varieties are very popular and occupy about 95 per cent of the total area under potatoes in the Nilgiris district; in quality they justify the popularity they command. Catriona, a long duration variety, also has a good nitrogen content, but its yielding capacity is low, while Ben Cruchan which is a high yielding variety has a low nitrogen content.

Effect of manuring on crop quality.—This investigation was a continuation of a previous work on the effect of manuring on crop quality with special reference to the nitrogen content and distribution of the various forms of nitrogen in that moiety. Previous work has shown that there was a difference in the type of protein of cereals depending on the type of manures applied.

This year's work was on the nitrogen partition in the herbage of cereals grown under different manurial treatments. The analysis of the herbage was undertaken since it was felt that, the leaf being the seat of metabolic activity in plants, any difference in manuring, if they were to produce differential intake of nitrogen, should be shown in the nitrogen content and distribution in the leaf more readily than in the grain which is the product of the ultimate metabolism.

The crops studied were as follows :—

Crop.	Manurial treatment.	Field or pot.
Paddy ..	Effluent water and channel water for irrigation.	Wet lands, central farm.
Maize ..	Cattle manure, mineral manure and no manure.	Tubs in pot culture house.
Ragi ..	Do. do.	Permanent manurial experiments.
Lucerne ..	Cattle manure and no manure.	Tubs in pot culture house.

The herbage was sampled at various stages of growth of the crop and analysed for total nitrogen and the nitrogen distribution. The results may be summarized as follows :—

(i) Manuring brings about a change in the total nitrogen content and in the distribution of nitrogen in the herbage of crop (cereal).

(ii) Manuring with ammonium sulphate gives a higher total N content, 20 per cent of the nitrogen and 50 per cent of the water soluble N being as Nitric Nitrogen.

(iii) In general the total nitrogen curve falls with the age of the crop, and so do the curves for the various fractions of N.

- (iv) The nitrogen content of lucerne is not affected by manuring, the probable reason being that, it being a leguminous crop, its mechanism of nitrogen fixation by the nodule bacteria makes it independent of other sources.

The investigation is in progress.

Animal nutrition—Protein requirement of working bullocks.—The work was continued and another series of experiment conducted for maintenance, 4 hours, 6 hours, and 8 hours of work, with the four experimental animals. The results obtained this year and that of the past years were collated and subject to statistical analysis. The results of the nitrogen balance (± 1.0 gm.) were the basis for determining the levels of intake and output of nitrogen and linear regression. Regression equations were fitted for the total nitrogen requirement at different levels of work, and their adequacy tested by the usual statistical method.

The results were as follows:—

(a) *For total nitrogen requirement in ration.*

(Fitted regression.)

Hours of work.	Actual value. Y.	Calculated value. y.	(Y - y)	(Y - y) ²
0	46	46.7	- 0.7	0.49
4	67	65.9	1.1	1.21
6	76	75.4	0.6	0.36
8	84	85.0	- 1.0	1.00

(Analysis of variance.)

Variation between hours of work due to	Degrees of freedom.	Sum of squares.	Mean square.
Linear regression	1	801	801
Deviation from linear regression	2	4	2
Total ..	3	805	..

(b) *For endogenous nitrogen as urinary nitrogen.*

(Fitted regression.)

Hours of work.	Actual value. Y.	Calculated value. y.	(Y - y).	(Y - y) ²
0	17	16.6	0.4	0.16
4	26	26.8	- 0.8	0.64
6	33	32.0	1.0	1.00
8	37	37.1	- 0.1	0.01

(Analysis of variance.)

Variation between hours of work due to	Degrees of freedom.	Sum of squares.	Mean square.
Linear regression	1	229	229
Deviation from linear regression	2	2	1
Total ..	3	231	..

The calculated values were very close to the actual value for total and endogenous nitrogen and, when these two equations were plotted, it gave straight line, which showed that the total N

intake required to give nitrogen equilibrium and the endogenous nitrogen output also at nitrogen equilibrium at the various levels of muscular work, were linear functions of the work done.

As has been stated before, a review of the extensive literature on the subject has shown to consist of two schools of thought, the one led by Mitchell holding the view that, normally and given a diet of sufficient calorigenic intake, increased metabolism of protein is not an inevitable consequence of muscular work, the other, led by Cathcart, feels that muscular effort results in a definite though often small increase in nitrogen output calling for an augmented protein intake to meet the extra need.

This investigation has shown that—

- (i) Muscular work is necessarily followed by an increase in the metabolism of protein as is shown by the need for increased protein in the diet to produce nitrogen equilibrium, and to balance the increased output of endogenous nitrogen.
- (ii) The quantum of dietary protein requirement to produce nitrogen equilibrium at different levels of work is a linear function of the quantum of work performed.
- (iii) The quantum of protein metabolised is also a linear function of the quantum of work performed.
- (iv) The increment in the quantum of dietary protein necessary to restore the animal to nitrogen equilibrium for each increment in quantum of work (about 5 gms. of protein for an increment of two hours work) is small, and considered from its calorigenic value is entirely inadequate to account for the energy required for the extra work performed. The significance of this small increase in the protein of the diet is therefore to be sought in causes other than inadequate caloric intake.
- (v) The nitrogen partition of the urine of the animals showed that the major part of the increased output of endogenous nitrogen was in the form of urea + ammonia, indicating that the deamination phase of protein metabolism was the most active. The excretion of creatinine was very regular amounting to 2.5—3.0 gms. per diem. Creatine excretion occurred sporadically and in insignificant amounts showing that, even at high levels of work, tissue breakdown resulted in the excretion of products of deamination, but not of creatine and creatinine. The excretion of creatine and creatinine followed Folin's law at all levels of work.
- (vi) The co-efficient of digestibility of protein remained unchanged at all levels of work.

Standard rations for working bullocks.—Based on the results of the above investigations, which has been in progress for a series of years now, it has been possible to formulate standard rations for working bullocks.

Data were collated from the agricultural research stations of this department on the usual rations for the working bullocks. This enquiry showed that, apart from the variety of concentrates and fodders being fed, depending on local conditions of availability, there was no uniformity in the quantities fed, nor was there any differentiation for various levels of work. In general the ration fed were all on the high side, supplying in some case very much more nutrients than is really necessary.

A set of standard rations were therefore drawn up based on the results of work done (reported in the above paragraphs) with the total nitrogen intake as the basis and allowing for a margin of supply over the values determined, since admittedly the values obtained during the investigation were with experimental animal under a rigorous control of all intake and work and the data obtained therein were the real basal requirement not capable of translation as such in general farm practice.

The suggested rations were as follows :—

TABLE.

Paddy straw as roughage (Nitrogen content 0.3 per cent).

(1)		Coconut pooaac. 3 per cent N.	Cotton seed. 3 per cent. N.	Gingelly cake. 5.4 per cent N.	Ground- nut cake. 8 per cent N.	Horse- gram. 3.6 per cent N.	Rice bran. 1.5 per cent N.
		(2)	(3)	(4)	(5)	(6)	(7)
		GMS.	GMS.	GMS.	GMS.	GMS.	GMS.
Maintenance	.. ..	1,000	1,000	600	400	850	2,000
Moderate work	.. ..	1,200	1,200	700	500	1,000	2,400
Heavy work	.. ..	1,600	1,600	900	600	1,350	3,200
Very heavy work	.. ..	1,800	1,800	1,000	700	1,500	3,600

Cholam straw as roughage (Nitrogen content 0.6 per cent).

		Coconut pooaac. 3 per cent. N.	Cotton seed. 3 per cent N.	Gingelly cake. 5.4 per cent N.	Ground- nut cake. 8 per cent. N.	Horse- gram. 3.6 per cent N.	Rice bran. 1.5 per cent N.
		(8)	(9)	(10)	(11)	(12)	(13)
		GMS.	GMS.	GMS.	GMS.	GMS.	GMS.
Maintenance	.. ..	300	300	170	110	250	600
Moderate work	.. ..	500	500	300	200	450	1,000
Heavy work	.. ..	850	850	500	330	750	1,700
Very heavy work	.. ..	1,000	1,000	600	400	850	2,000

NOTE.—For a bullock of average live weight of 700—1,000 lb.

This suggestion was circulated to all the agricultural research stations for trial with their working bullocks with instructions for individual feeding and regular hours of feeding. The officers in charge of the stations were requested to report at the end of a few months whether animals remained in condition or not before any adjustments were made.

The rations suggested were for maintenance, moderate and heavy and very heavy work. The ration for maintenance being the basic one and those for the three levels of work being superimposed on the basic one, according to the conception of the "slab system."

Thus while the maintenance ration consisted of one slab, that for moderate work two, for heavy work three, for very heavy work, four slabs. If a bullock is taken off from very heavy work and only has moderate work the two top slabs are reduced and if the work is to be given again at the top level the two slabs restored. The slabs are all for concentrates based on a basic ration of straw fed *ad-lib* (about 15 lb. being the maximum quantity consumed by an average bullock).

The reports from the agricultural research stations are awaited.

Microbiology—(a) *Studies in nitrogen fixation*—*Azotobacter inoculation of cereals*.—Chitrai cholam was sown with and without inoculation in field numbers 19-A and 60 of the Central Farm. The crop was below normal owing to unfavourable season and results were not significant.

(b) *Photo-nitrification*.—The hypothesis formulated by Dr. Dhar of Allahabad that nitrification in the soil was more a photochemical process than due to the activity of nitrifying organisms was tested in a carefully controlled experiment. The claim that sunlight causes considerably more nitrification than that caused by bacteria, has been a revolutionary one controverting much of the work done till now and accepted as the correct view.

In scientific work no new hypothesis stands condemned unless it is controverted by work beyond all doubt of accuracy, in fact all new theories are welcomed, the more heterodox the better and Dhar's hypothesis postulated in a tropical country like ours has startled the scientific world by its implications. It is well known that the intensity of solar radiation in a country like ours and more so in our Presidency is of an intensity unrivalled in most other countries. If the radiant energy received on the soil were to be of more importance than that of bacterial action in nitrifying, it might in some measure explain the fertility of our soils which after centuries of intensive cultivation are still productive in spite of the notorious deficiency of additions of manurial substances dictated by a deficient economy of agriculture through long periods of years.

An experiment was started in March 1938, with soils in flasks, duplicating Dr. Dhar's work as closely as possible. The soil in the flasks was protected from contamination by air, by plugs of cotton wool.

The details of treatment are given in table below. The soils were exposed to sunlight, including those kept in the dark by painting over the flasks with black paint to maintain uniform temperature conditions.

The hours of sunshine were computed from records on the Campbell Stokes Sunshine recorder. The analysis of the soils after the exposure to sunlight were all carried out by standard methods as followed in this laboratory so that the results be beyond all doubt of scientific accuracy.

Photo-nitrification.

Serial number.	Treatment.		Soil exposed to sunlight.				Soil (1) inoculated in solution.			
			Composition.		Total.	N PER CENT.	Nitrifying capacity.		MGMS.	
			NH ₄ - N	MGMS. NO ₃ - N			NH ₄ - N	NO ₃ - N		
C1	Control.	Unsterilized + 0.5 per cent (NH ₄) ₃ PO ₄	..	..	..	..	..	..	..	..
C2	"	Sterile	..	..	..	..	..	..	..	..
C3	"	Unsterilized + 1.0 per cent	..	..	..	..	..	..	..	..
C4	"	Sterile	..	..	..	..	..	..	..	..
1	Exposed to sunlight	300 hrs. Sterile	..	..	..	..	..	..	..	..
2	"	600 "	..	..	..	..	..	..	..	..
3	"	300 "	..	..	..	..	..	..	..	..
4	"	600 "	..	..	..	..	..	..	..	..
5	"	300 "	..	..	..	..	..	..	..	..
6	"	600 "	..	..	..	..	..	..	..	..
7*	"	600 "	..	..	..	..	..	..	..	..
8*	"	600 "	..	..	..	..	..	..	..	..
9	Kept in darkness	300 hrs. Sterilized	..	..	..	..	..	..	..	..
10	"	600 "	..	..	..	..	..	..	..	..
11	"	300 "	..	..	..	..	..	..	..	..
12	"	600 "	..	..	..	..	..	..	..	..
13	"	300 "	..	..	..	..	..	..	..	..
14	"	600 "	..	..	..	..	..	..	..	..
15	"	300 "	..	..	..	..	..	..	..	..
16	"	600 "	..	..	..	..	..	..	..	..

Nos. 7 and 8 rejected due to growth of weeds.

V.S. = Very strong.

S = Strong.

The results of the investigation are unequivocal and may be stated in brief as follows. No effect of the influence of sunshine ranging from 300 to 600 hours (at an average of 8 hours per diem) could be noticed on the nitrification in sterilized and unsterilized soils, kept in the sunlight for periods of 300 and 600 hours and in the dark keeping temperature conditions equal.

These results will be shortly published in detail as a separate communication.

Milk transport.—One of the problems of modern days is the satisfactory marketing of perishable biological products of which milk is one of the most important. At the request of the Imperial Dairy Expert to the Government of India an investigation of a preliminary and exploratory character was undertaken on the problem of transport of milk from Bangalore (from the Imperial Dairy Institute) to Madras, a distance of about 250 miles within a period of twelve hours from time of milking till arrival, at Madras. Since Coimbatore is at about the same distance away and since it takes the same time by train, samples of milk variously treated were despatched from Bangalore and received here the next morning and taken up for analysis immediately.

The methods of processing milk before despatch were, pasteurization and chilling and packed in usual milk containers with and without insulating packing.

A new method of packing in mud pots was tried also.

It was found that for the period of transit in ordinary luggage vans pasteurization was the best method of processing milk before despatch and that packing in mud pots was the best method of packing, the mud pot being cheap can be discarded after arrival of milk and no empty return charges will have to be met.

Pasteurizing and packing in mud pots were seen to be the best method of retarding bacterial multiplication during transit.

Malting of cholam and other cereals.—(1) *Clinical tests on cholam malt foods.*—To test the suitability of malt foods for the use of infants and invalids, a series of tests were carried out by the Surgeon-General to the Government of Madras in the hospitals under his control in Madras City, with malt food prepared in this laboratory. The hospitals at which such tests were carried out were as follows:—

(i) Government General Hospital, Madras.

(ii) The Prince of Wales Hospital for Children (the Government Victoria Caste and Gosha Hospital, Triplicane, Madras).

(iii) The Women and Children Hospital, Egmore, Madras.

The supply of cholam malt food in vacuum packed tins was made to these institutions, in batches beginning with the first supply in June 1938 and ending with the last supply in October 1938, the total quantity so supplied was 45 lb.

In the month of March 1939 reports from the various hospitals were received. On the whole the reports were favourable. Most of the physicians reported that the food was good and produced no gastro-intestinal trouble. Only one physician of the General Hospital was of the opinion that it was not accepted readily by children "owing to its inedibility and lack of elegance."

Further samples are being sent this year for similar tests with cholam malt food and also blended rice and cholam malt food (*vide infra*).

(2) *Preparation of malt from different cereals.*—Using the improved technique, the following quantities of cereals were malted during the year on the bulk scale:—

	LB.
Periyamanjal cholam	640
Cholam other varieties	148
Ragi	93
Paddy	116
Wheat	23
Barley	10
Total	1,030

(3) *Malting of varieties of cholam.*—Till now the investigation has been mainly on malting of Periyamanjal cholam, a well-known Coimbatore variety but space bound within the geographical and climatic conditions of the Coimbatore district. This year the work was extended to the malting on a large scale of other varieties of wide geographical distribution. The following varieties were tried and found to malt quite as well as Periyamanjal cholam:—

- | | |
|---------------------------|---------------------------|
| (1) Chinnamanjal. | (6) Cholam A.S. No. 2095. |
| (2) Chitrai. | (7) Nandyal No. 29/65. |
| (3) Chiltex. | (8) Nandyal No. 28/3. |
| (4) Cholam A.S. No. 4250. | (9) Nandyal T-6. |
| (5) Cholam A.S. No. 4376. | (10) Bellary T-1. |

Items (1)—(6) were received from the Millets Specialist, items (7)—(9) from the Farm Manager, Agricultural Research Station, Nandyal, and item (10) from the Superintendent, Dry Farming Station, Hagari, Bellary district, to whom thanks are due for the supply of sufficient fresh seed material of pure strains for malting trials.

(4) *Malting of paddy.*—Successful attempts were made at malting of paddy. Studies in the time of steeping and couching were carried out and a high grade malt obtained. Paddy with its easily removable husk, its low protein, fat and fibre content lends itself to malting and in the making of a high grade malt. The time of steeping should be about 48 hours.

(5) *Blending of cereal malts.*—It was found possible to blend malted flours of cholam and rice to give any desired combination of factors desired in a malt for infant or invalid food. Cholam malt is higher in protein than rice malt, but contains higher amounts of fibre and fat, so by combining the two it has been found possible to produce a food with a low fibre and fat content and with a fair protein content. Milk powder was added to give a complete malt milk food as is usually placed on the market by foreign manufacturers.

The table below gives the composition of the blended malt foods prepared :—

	Water.	Protein.	Fat.	Ash.	Starch sugars, etc.	Remarks.
	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	
Cholam malt food.	7.7	9.5	3.4	1.4	78.9	} 60 to 70 per cent "Extract."
Rice malt food ..	7.3	6.2	2.1	1.4	83.0	
Blended cholam and rice malt food ..	8.2	7.6	2.5	1.4	80.3	
Malted milk food..	7.9	11.2	1.8	2.1	77.0	

(6) *Semi-factory scale plant for malt-making.*—In the month of February 1939, Government sanctioned the making of an experimental plant for making malt by a continuous process untouched by hand for trial before the process is translated into large-scale production. The Industrial Engineer to the Government discussed the process and has drawn up detailed plans and estimates for such an experimental plant which is awaited for actual trial.

(7) *Therapeutic products from malt extract.*—Of the cereals investigated cholam and paddy lend themselves easily to the manufacture of malt foods by the virtue of the easy removal of husks after malting. Ragi grain also malted with equal facility but because it is difficult to remove its husk it is not suitable for making of foods but can be used for the making of malt extracts. The malted grain is crushed and extracted with water and the extract concentrated *in vacuo*, filtered and again concentrated *in vacuo*. The resulting malt extract is thick and viscid and suitable for mixing with cod liver oil, etc., for making malt extract foods.

During the year attempts were made to prepare malt extract foods of the type of Kepler's Extract and cod liver oil with calcium and phosphorus and also a preparation with malt extract and fish liver oil with iron.

To avoid the use of imported cod liver oil which is high priced, "Galliol" an oil from shark liver, prepared by the Madras Fisheries Department was used to mix with malt. This locally produced oil has a vitamin A potency ten times that of cod liver oil and proved a very good substitute for cod liver oil. The homogenising of the shark liver oil and malt extract was easy and the two phases of the mixture—oil and water soluble malt extract formed a stable emulsion, by mere stirring with an electric stirrer

at about 2,000 revolutions per minute. The incorporation of glycerophosphate containing calcium and phosphorus in glucose syrup and iron citrate solution in glucose syrup was also easy and did not disturb the stable emulsion.

In addition to these, two preparations for growth in children and for anæmia and similar pathological conditions in adults, simple malt and glucose mixture were prepared for use as an energiser.

Work is in progress on the making of a peptonemalt preparation resembling Bovril.

Active carbon and jaggery—*Active carbon*.—Active carbon was made from paddy husk on a bulk scale and 1,500 lb. prepared and brought to stock. There was however little demand from District Officers. A few private parties were supplied with small quantities for experimental purpose.

Open pan sugar from sugarcane and palm juice.—A series of experiments was conducted on the making of open pan sugar with sugarcane and coconut palm juice, with special reference to the method of making rab, and temperature control after strike point and methods of hastening crystallization of sugar. It was found that rabs struck at 118°C gave the best yield of sugar. These rabs after striking were kept at a temperature of 55°–60° C and concentrated further with frequent agitation, and produced bigger crystals of sugar. The introduction of palm leaf fibre into the rab when it had cooled to about 98°C hastened the formation of big crystal.

With coconut juice the method of making good sugar is—the juice after deliming with phosphate is concentrated to rab at 114°C and then cooled to 98°–100°C and coconut leaf midribs are introduced and the rab kept at about 45°–30°C for four or five days. The fibres are then removed, and the rab, further concentrated at the same temperature stirring constantly, is then centrifuged.

New method of filtration.—With the use of active carbon for filtration, one difficulty was the length of time required for filtration. A syphon filter was devised and tried in large scale filtration.

The method adopted was—the cane juice was boiled with active carbon and allowed to settle, and the supernatant liquid was decanted into the filter which had 12 inches coarse gravel and then a layer of active carbon. Filtration proceeded quickly and in the trial 250 lb. of juice filtered in 12 minutes and 1,000 lb. juice in just less than an hour.

COIMBATORE,
3rd August 1939.

P. VENKATARAMIAH,
Government Agricultural Chemist.

ADMINISTRATIO REPORT OF THE GOVERNMENT ENTOMOLOGIST FOR THE YEAR 1938-39.

I

I beg to submit the following report on the activities of the Entomological section for the year-ending 30th June 1939.

II. CHARGE.

I continued to be in charge of the section as Entomologist throughout the year.

III. ENQUIRIES AND NOTEWORTHY PESTS OF THE YEAR.

During the period under report 468 enquiries, reports or requests for help were received from various parts of the Presidency and attended to in person by members of the staff wherever possible or suitable advice was given by correspondence. This item of work has taken up a good portion of my time and that of my staff. In addition to the enquiries received by the section, the Entomological Assistants posted to the different circles in the Presidency also dealt with a number of enquiries.

The following are some of the noteworthy pests which received attention during the year :—

- (1) *Agathi*.—The stem weevil (*Alcidodes bubo*) from Palur.
- (2) *Brinjal*.—*Epilachna* beetles from Coimbatore, Pollachi, Tinnevely, St. Thomas' Mount, Vriddhachalam and Tenkasi; *Aphis* from Coimbatore and Jassids (*Eutettix* sp.) from Coimbatore.
- (3) *Ber*.—Fruit flies (*Dacus correctus* and *Carpomyia vesuviana* from Thottiam.
- (4) *Cardamoms*.—Thrips (*Teniothrips cardamomi*) from Madura and Valparai and the castor-seed borer (*Dichrocrocis punctiferalis*) from Cumbum, Ootacamund and Valparai.
- (5) *Coconut*.—The coconut caterpillar (*Nephantis serinopa*) from Coimbatore, Madura, Tirur, Dindigul and Gudiyattam; Termites from Erode; the Rhinoceros beetle (*Oryctes rhinoceros*) from Palur; bagworms (*Psychids*) from Pilicode; scale insects (*Aspidiotus* sp.) on seedlings from Coimbatore; the coconut weevil (*Rhynchophorus ferrugineus*) from Coimbatore and field rats damaging tender coconuts from Bolampatti.
- (6) *Cotton*.—Flea beetles (*Monolepta* sp.) from Coimbatore; bollworms (*Platyedra* and *Earias*) from Vedaranniyam; aphids from Coimbatore; mealy bugs from Kulittalai;

Eriophyid mites from Maruteru and Siruguppa and field rats damaging bolls from Tiruppattur.

- (7) *Cholam*.—The red hairy caterpillar (*Amsacta albistriga*) from Kinathukadavu and the gram caterpillar (*Chloridea obsoleta*) on earheads from Madura.
- (8) *Chillies*.—Mealy bugs (*Pulvinaria* sp.) from Bhavani.
- (9) *Cephalandra indica*.—Fruit flies (*Dacus brevistylus*) from Coimbatore.
- (10) *Citrus*.—Aphids (*Aphis tavaresi*) from Coimbatore; scales (*Mytilaspis* sp.) from Wynad; the leaf miner (*Phyllocnistis citrella*) from Kulittalai; the Lemon butterfly (*Papilio demoleus*) from Chingleput and Kulittalai and *Eriophyid* mites from Kodur.
- (11) *Daincha*.—The Noctuid (*Prodenia litura*) from Coimbatore; the Geometrid (*Semiothisa pervolvata*) from Kumbakonam and thrips from Coimbatore.
- (12) *Groundnut*.—The red hairy caterpillar (*Amsacta albistriga*) from Pollachi; 'Surul' puchi (*Stomopteryx nerteria*) from Coimbatore and thrips from Coimbatore.
- (13) *Grasses*.—The army worm (*Cirphis albistigma*) from Hosur.
- (14) *Guava*.—The fruit-sucking moth (*Ophideres* sp.) from Thottiam.
- (15) *Jasmine*.—The Pentatomid bug (*Antestia cruciata*) from Coimbatore and Trichinopoly and *Eriophyid* mites from Coimbatore.
- (16) *Lablab*.—Aphids (*Aphis medicagenis*) from Coimbatore.
- (17) *Lupins*.—Semilooper caterpillars from Nanjanad and Hagari and *Agromyzid* stem borers from Nanjanad.
- (18) *Mango*.—The stem borer (*Batocera rubus*) from Anuppatti; fruit flies (*Dacus* sp.) from Coonoor and Salem and the mango hopper (*Idiocerus* sp.) from Coimbatore.
- (19) *Paddy*.—The swarming caterpillar (*Spodoptera mauritia*) from different parts of Malabar; the grasshopper (*Oxya velox*) from Tanjore; the Chrysomelid (*Leptispa pygmaea*) from Malabar; the stored paddy borer (*Rhizopertha dominica*) from Musiri; the root grub (*Echinocnemus oryzae*) from Maruteru; the stem borer (*Schænobius incertellus*) from Kavali; Termites from Peralam; field rats from Semmedu, Ambasamudram and Cochin and snails from Guntur.
- (20) *Plantain*.—Tingids and the scale (*Aspidiotus* sp.) from Coimbatore.

- (21) *Pepper*.—Scale insects (*Mytilaspis* sp.) from Wynad.
- (22) *Pomegranate*.—The fruit borer (*Virachola isocrates*) from Madura.
- (23) *Ragi*.—The pink borer (*Sesamia inferens*) from Gingee; root aphids (*Tetraneura hirsuta*) from Coimbatore; *Laphygma exigua* in nurseries from Idigarai and Madanapalle and the paddy mealy bug (*Ripersia oryzae*) from Coimbatore.
- (24) *Rose*.—Thrips from Coimbatore and mites from Kodaikanal.
- (25) *Soya beans*.—The groundnut 'surul' (*Stomopteryx nerteria*) from Coimbatore.
- (26) *Sugarcane*.—Moth borers (*Argyria sticticrasis* and *Diatraea venosata*) from Manjeri and *Scirpophaga* sp. from Natham and mites (*Paratetranychus* sp.) from Maruteru and Musiri.
- (27) *Sunnhemp*.—The hairy caterpillar (*Utetheisa pulchella*) from Ayakampalayam and thrips from Coimbatore.
- (28) *Tapioca*.—*Tetranychid* mites from Vellore.
- (29) *Tea*.—Mites (*Tetranychus* sp.) from Kateri (Nilgiris).
- (30) *Tomatoes*.—Thrips from Palamcottah.
- (31) *Turmeric*.—Aphids and Tingids from Erode.

IV. TEACHING.

In G.O. No. 1704, Development, dated the 14th July 1938, Government have passed orders re-amalgamating teaching and research. The teaching staff reported to me for duty on 2nd August 1938.

During the year under review, the following lectures and practical classes were held :—

	Lectures.	Practical classes.
B.Sc. I Year	61 Regular 3 Special.	29
B.Sc. II Year	32 Regular 4 Special.	28

Of the regular lectures taken for the second year, four were delivered by me.

Besides these, short courses in "Insect pests" and "Bee-keeping" were held in November 1938 and February 1939, respectively. Twelve students attended the former and fourteen the latter. Both the courses were mainly of a practical nature and the students took a very keen interest in the subjects.

V. SPECIAL INVESTIGATIONS.

Intensive studies were made of some of the major crop pests of this Presidency and considerable data gathered. The more important of these items of research are the following:—

Pests of cotton.

1. *The cotton stem weevil (Pemphres affinis).*—The studies under this head were carried out under two different auspices. Till the end of October 1938 these formed part of the scheme under the Indian Central Cotton Committee after which this has been continued as part of the work of the section.

Trend of incidence and parasitism in the seasonal crop.—About 900 cotton plants were examined. Roughly three generations were undergone by the pest from October 1938 to March 1939. From April onwards the generations were so much blended and overlapped that they were rendered indistinguishable; yet roughly two supplementary generations were traced till the complete removal of the crop by June. The incidence increases from an initial 9·2 per cent to 95·5 per cent in June with intermittent oscillations. The trend of live population showed a decline from 73 per 100 plants to 42 in the closing period.

Cotton Pemphres parasite.—Mass breeding and studies on the biology and seasonal fluctuations of the species—wingless *spathius*—have been continued. About 509 parasites have been reared from laboratory and outdoor cages. The life cycle duration ranged from an average of 23·24 days in the cold season (October to February) to 16 to 17 days in the summer months (March to June).

Alternate food plants.—About 1,000 plants belonging to about thirteen different species have been examined in detail during the latter part of the year. The heaviest infestation was in *Triumfetta rhomboidea* with the percentage ranging from 53·3 to 95·5 per cent. One species—*Urena sinuata*—may tentatively be taken as a new record where *Pemphres* infestation is suspected. Parasitism in alternate food plants oscillated between 7·5 per cent and 32 per cent. From February to June, the species—spotted *Spathius*—was entirely absent. The other Braconids—*Rhaconotus* spp.—were not recovered during the period October to June. The internal chalcidoid continued to be the dominant species.

Host preferences.—This study is a new development in the latter part of the year. Preliminary tests with *Triumfetta* spp. *Malvastrum* and cotton were carried out. Some differences in behaviour of population from *Triumfetta* and cotton have been observed which seem to suggest the occurrence probably of different strains. Cotton adults seem to be more attracted to *Malvastrum*

than to others like *Triumfetta*, *Sida glutinosa* or *Hibiscus vitiifolius*. *Triumfetta* and cotton populations show marked preferences for their parental food plants when both are presented simultaneously.

Distribution of the pest.—By correspondence and later from published references a new region of its occurrence, namely, Siam, has been noted where it has been recorded as a pest of exotic cottons. The significance of this observation lies in the contiguity of this region with Indo-China wherefrom negative reports have been received.

2. *The cotton bollworms (platyedra and Earias).*—The incidence of bollworm infestation in the shed buds and bolls in Cambodia cotton was studied by examining the material collected daily from about two cents area. Owing to unusual weather conditions budding and bolting were very low throughout December 1938 and January 1939. It was only possible to collect the shed buds and bolls from February onwards for the above studies. Most of the shed bolls were found to show signs of a disease caused by—*Bacteria malvacearum* and they were kindly identified by the Mycologist as such. The total bollworm incidence was very low as compared with that of the previous year. Field parasitism was also poor due to the paucity of the host and perhaps due to the prevalence of drought conditions. The incidence of the bollworms and their parasites is given below.

TABLE.

Year and month.												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
		Total collected.	Attacked by <i>Bartas fabia</i> and <i>insulana</i> .	Attacked by <i>Platyedra</i> .	Total attacked.	Attack per cent by <i>Bartas</i> .	Attack per cent by <i>Platyedra</i> .	Total per cent attack.	Population of <i>Bartas fabia</i> .	Population of <i>Platyedra</i> .	Percentage Parasitization of <i>Bartas fabia</i> .	Parasitization of <i>Platyedra gossypiella</i> .
1938—												
January	..	2,154	100	7	107	4.6	0.4	5.0	5/0	1/0	..	..
	..	19,293	386	70	466	2.0	0.3	2.3	53/0	33/1	..	..
February	..	114	8	4	12	7.0	3.5	10.5	3/0	2/0	..	..
	..	2,386	100	36	136	4.2	1.8	6.0	16/1	14/0	..	..
*												
May	..	10,186	659	1,975	2,634	6.4	19.8	26.9	193/4	279/15	2	5.4
	..	2,307	506	559	1,065	18.0	23.6	41.6	190/4	472/67	2	14.0
June	..	2,972	705	189	891	22.2	7.8	30.0	166/0	36/0	..	..
	..	1,350	519	139	658	39.0	23.0	62.0	259/0	68/0	..	..
July	..	1,013	221	239	460	22.4	23.0	45.4	124/0	95/0	..	..
	..	332	76	72	148	20.6	24.6	45.4	150/0	45/0	..	..
August	..	1,620	478	339	814	29.7	20.9	50.6	150/0	169/12	..	7.09
	..	457	180	150	330	44.8	32.6	77.4	70/0	48/1	..	2.0
1939—												
February	..	6,400	42	38	80	0.05	0.05	1.0	46/0	15/0	..	..
	..	1,434	10	10	20	0.75	0.75	1.5	23/0	23/0	..	..
March	..	476	50	24	74	10.6	4.9	15.5	52/0	18/0	..	..
	..	1,182	121	53	174	14.6	4.5	19.1	58/1	12/0	1	..
April	..	1,231	227	8	235	17.4	1.61	19.01	77/0	9/0	..	..
	..	256	114	5	119	44.4	2.5	46.9	39/0	1/0	..	..

* In March and April 1938 an December 1938 and January 1939 there was practically no material for examination.

Some attention was paid to the study of alternate host plants. Pods of *Hibiscus vitifolius* were examined. The incidence of *Earias fabia* in 907 pods examined was 18.6 per cent and parasitisation by *Microbracon greeni* 24.4 per cent.

Studies of bollworm parasites have once again shown that *Microbracon lefroyi* attacks *Earias fabia* caterpillars in cotton buds and bolls under field conditions and has not so far been reared from the larvæ infesting *Hibiscus vitifolius* pods. Nor has *Microbracon greeni* which parasitises the *Earias* caterpillars in *H. vitifolius* and *Abutilon* pods, ever been reared in *Earias* larvæ in cotton buds and bolls under field conditions.

Trapping trials were made for the first time using gingly and groundnut oil cakes. The cakes were powdered and soaked in water and kept exposed in shallow trays in cotton fields. A few *Platyedra* and *Earias* moths were found attracted to the latter but the catches were poor.

Pests of Sugarcane.

Sugarcane moth borers.—The internode borer (*Diatraea venosata*).—The habits and life history of the pest and the extent of damage to canes were studied. The percentage of attack of the borer at the time of harvest for six varieties grown in the Central Farm wet lands in plots replicated four times was noted. From Tables I and II it will be seen that varietal resistance to attack is not significant.

TABLE I.

Analysis of variance of percentage of canes attacked.

Variation.				Degree of freedom.	Sum of squares.	Mean squares.
Variety	..	..	..	5	1,245.1	249.0
Blocks	..	..	..	3	269.7	.. *
Error	..	..	..	15	1,810.1	120.7

* P. greater than .05

TABLE II.

Mean percentage of attack.

Co.	419	..	..	..	..	..	51.5
Co.	417	..	..	..	..	..	60.4
J.	247	..	..	..	..	..	61.3
Co.	213	..	..	..	..	..	43.1
Poj.	2878	..	..	..	..	..	63.7
Co.	413	..	..	..	..	..	51.6

The White moth borer (Scirpophaga).—The confusion regarding the spotted and non-spotted forms of this moth has been removed as a result of our studies. Both the forms have now been identified as one species—*S. rhodoproctalis*.

The cane borer control experiments.—The young canes when about five weeks old were given the following treatments:—(a) earthing up of young canes so as to cover the basal leaf sheaths accompanied by a good irrigation, (b) removal of basal leaf

sheaths, and (c) combination of (a) and (b). The treatments together with the control were replicated thrice. Counts of infestation were taken 15, 45 and 75 days after treatment. The treatment differences were not statistically significant for 75 days after treatment and 15 days after treatment while these were significant for 45 days after treatment.

Natural enemies of cane borers.—*Tetrastichus ayyari* was for the first time noted as a pupal parasite of *D. venosata* and its habits studied. Other parasites of borers which received attention included *Apanteles flavipes* and *Rhaconotus* sp.

Cholam and maize borers.—Cholam and maize plants were examined to see whether the cane borers were also noted in these two crops.

Imperial Council of Agricultural Research Scheme.—Survey of cane areas round about Anakapalle and Gudiyattam for the study of cane pests has been started. A detailed account of the work will be given in the scheme report.

Pests of chillies.

The chillies thrips (*Scirtothrips dorsalis*).—Tobacco and sulphur dusting trials were continued this year also. Cooper's special spreading sulphur of 300 finesse was used throughout. The two treatments and the control were replicated eight times in eight blocks. The experiment was designed on the randomized block layout. Each plot was 2.66 cents but the experimental area measured only 1.33 cents; the former contained four central rows with two guard rows on either side. Two rounds of dustings were given 84 and 169 days after planting, but as in the previous season the dusts were washed out by rain in less than three days after dusting. There were six pickings of ripe pods in all. From Tables I and II presented below it would appear that the treatment effects are significant for the first year and not so for the second year. From Tables III and IV it will be seen that tobacco dust gave an increase of 6.6 per cent for the first year and 6.2 per cent in the second year but the increase was not significant. Sulphur dust was found to act deleteriously later in the season depressing the yield consistently in both the years. A decrease of 19.8 per cent in the first and 15.5 per cent in the second year was noted. It must be admitted that both the seasons were extremely bad owing to the total failure of the monsoons.

TABLE I.

Analysis of the variance of yield of all pickings—1937-38.

Variations.	Degree of squares	Sum of squares.	Mean square.
Treatments	2	494,885	247,433
Blocks	5	2,473,251	..
Error	10	463,240	46,324
Total ..	17	3,431,356	P. .05

Treatment effects are significant.

TABLE II.

Analysis of variance of the yield of all pickings—1938-39.

Variations.				Degrees of freedom.	Sum of squares.	Mean square.
Treatments	..	..	..	2	1,014,732	507,366
Blocks	..	..	..	7	22,262,046	..
Error	..	..	..	14	4,745,284	338,949
Total	..	..	..	23	28,022,062	P. 0.05

Treatment effects are not significant.

TABLE III.

1937-38 experiments.

Picking.	Tobacco.	Sulphur.	Control.
1	165.8	149.5	100
2	94.4	62.7	100
3	99.5	63.0	100
4	100.1	92.3	100

TABLE IV.

1938-39 experiments.

Picking.	Tobacco.	Sulphur.	Control.
1	109.7	101.5	100
2	105.7	67.8	100
3	105.6	101.5	100
4	132.4	82.2	100
5	98.8	72.3	100
6	106.4	97.2	100

Pests of paddy.

The paddy stem borer (Schoenobius incertellus).—The light trap trials at the Central Farm wet lands were continued. During the period of the crop from planting to harvest there were two brood emergences, one during the latter half of October and the other at the end of November. From August to November there were 49 days trapping. Counts were taken of dead hearts during September, November and December at different distances from the light. The percentage of affected plants and of white ears are given below :—

TABLE.

	Near trap.	60-70 yards.	120-130 yards.	180-200 yards.	200-250 yards.	300-350 yards.	Beyond 360 yards.	Beyond 400 yards.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.
September ..	1.87	2.66	0.83	2.42	2.83	2.01	6.50	..
November ..	0.78	3.42	2.28	4.46	8.86	2.19	5.17	..
December ..	3.23	0.14	3.38	4.60	4.10	2.66	5.50	8.66
December white ears.	0.93	0.30	0.56	0.80	0.97	0.58	1.05	2.30

In cases of mild attack as in the wet lands the yield does not get affected much. Further tests and observations have to be carried out in especially heavily infested localities.

Pests of fruit-trees.

The Ber fruit flies (Dacus correctus and Carpomyia vesuviana).—Studies on her fruit flies were made at Panyam. Life history of the flies was partially worked out. The incidence of the flies was very severe ranging from 90 to 100 per cent. While *Carpomyia* infested fruits from just over tender to ripe age, *Dacus* was noted to breed only in ripe fruits. Control measures tried included the use of essential oils, lures, spraying poisoned molasses and raking up of soil underneath the trees. Amyl acetate, Citrol,

Citronella oil and lemon grass oil gave negative results. Clensel, a patent preparation, attracted *D. correctus* flies but the number captured was nothing when compared with the swarms found hovering about the trees. Poisoned molasses attracted large numbers of flies of both the species and they were noted to feed on the sprayed material on the leaves. Pupae were noticed in numbers when the soil underneath the trees was raked up. This method, if carried out by all the garden owners, should prove effective. It is interesting to note in this connexion that though the incidence of fruit flies was high yet in some of the gardens visited a few trees were noticed in which the fruit fly incidence was only 2 per cent. Such trees were marked and observations will be made in the coming season to confirm the results of the previous year.

Different varieties of infested fruits were collected to study the species of fruit flies present in this Presidency. The dreaded Mediterranean fruit fly has not been observed though it is reported from North India.

The woolly Aphis (Eriosoma lanigera).—This was studied at the Pomological Station at Coonoor. The pest makes its appearance in April-May and increases in numbers in the later months. In May, Nicotine sulphate at 1 oz. in 5 gallons of water was sprayed and in June another spray was given with not very encouraging results. The root forms were not affected when "Seekay" was soaked in the soil and the pest was found to increase in numbers later. Biological control of the pest by the introduction of its parasite—*Aphelinus mali*—from England is under consideration. Of the varieties grown in the Pomological station, *Winterstein* and *Democrat* are badly affected.

Pests of groundnut.

The groundnut "*Surul*" (*Stomopteryx nerteria*)—*Life history.*—The total life cycle of the pest is 21-24 days, the average for December, February and March being 23, 22 and 19 days, respectively. The maximum longevity was 35 days; without food the moths did not live for more than 4 days.

Alternate host plants.—Soya bean was also found to suffer badly in the Central Farm.

Natural enemies.—The following natural enemies were noted:—Three chalcids; one *Apanteles*; one *Microbracon*; one *Chelonus* and one *Bethylid* on larvæ and one *Brachymeria* sp. on pupæ. A predator was also found feeding on the larvæ and pupæ.

Incidence studies.—Seventy-four varieties were examined, the degree of incidence being studied from the number of leaves affected. The highest incidence noted (14.2 per cent) was in *Recon quista* while the lowest (5.8 per cent) was in *Ar. namby quræ*.

Light trap trials.—Although late in the season, light trap trials were conducted. Counts of moths for two hour periods from 6-30 p.m. to 6-30 a.m. were made. Both petromax and hurricane

lights were used. The figures show that petromax gave more catches than hurricane and that moths were attracted to light throughout the night.

The loss of crop due to the pest, the number of lights necessary per acre and the period for which the light trap should be set up, etc., will be worked out in the coming season at Tindivanam.

The groundnut earwig (Euborella stali).—Generally earwigs are not noted as pests of crops. But, for the first time, a species of earwig—(*Euborella stali*)—was observed to do damage to groundnut pods at Tindivanam. The same insect was also noticed in the Central Farm groundnut crop.

The life cycle of the pest varied from 42 to 71 days, the egg and nymphal periods being 7–11 and 35–60 days. There were four moults. The longevity in the case of two specimens was found to be 132 and 160 days.

The percentage of infestation of earwig in different varieties of groundnut grown in the Central Farm is given below :—A.H. 477 (20·2 per cent) ; A.H. 113 (20 per cent) ; A.H. 334 (14·6 per cent) ; A.H. 25 (13·8 per cent) ; A.H. 417 (13·2 per cent) ; A.H. 186 (11·9 per cent), and A.H. 86 (8·8 per cent).

Pests of tobacco.

The tobacco caterpillar (*Laphygma erigua*).—Studies on the caterpillar pest of tobacco nurseries were made at Chirala. Trials of growing ragi as a trap crop were successful. Collection of egg-masses from the ragi edges and the pulling out of the ragi seedlings and replacement of the same at five days interval gave considerable reduction of the pest.

Pests of coconut.

The coconut beetle (Oryctes).—Studies on the methods of control of the coconut beetle were continued. Systematic removal of beetles from trees and sanding of beetle holes were tried. The attack of the beetle continued to some extent though sanded holes were seldom retenant. To ascertain the extent of such relief counts of the number of attacks and population in sanded and unsanded trees have been started.

Fermented castor cakes and castor pods were used as baits to attract the adult beetles but were not successful.

The studies on the green muscardine fungus parasitic on beetle grubs have shown (1) that the fungus remains in the dung material for eight months undestroyed, (2) that when the surface layer of dung gets dry small quantities of fresh dung should be added to attract the beetles for egg-laying, and (3) that mature grubs are affected even within 20 days. The best time for inoculation has to be worked out. Experiments are being conducted in different parts of the Presidency to find out whether the use of the fungus gives satisfactory results under different conditions.

Pests of cardamoms.

The cardamom thrips (Taeniothrips cardamomi).—This insect damages the racemes and young capsules and produces scabby fruits. The pods appear shrivelled with slits in the skin. As the appearance of the pods is spoiled its market value is depreciated. In some of the estates in the Anamalais the infection was as high as 69 per cent. In addition to the direct damage done to the pods the insect is believed to be a vector of the cardamom mosaic or marble disease. At the instance of the planters at Anamalais a study was made of this pest and its control.

Experiments have been started at Korangumudi estate with the object of finding out whether sprays and dusts could reduce the incidence of the pest and thereby reduce the scabbiness of the pods. The experiment was designed on the randomized block lay-out; there were six blocks and five treatments. The treatments consisted of (1) sulphur dusting, (2) tobacco decoction spraying (0.05 per cent), (3) potash fish oil soap spraying (1 lb. in 6 gallons), (4) Bordeaux mixture (1 per cent with vegetable oil) spraying, and (5) control. Each plot consisted of nearly 20 clumps in four rows of which the pods of ten plants of the two inner rows alone are to be examined for the extent of scabbiness and population of thrips both before and after the treatment.

The cardamom mosaic vector studies did not prove successful. Thrips from severely affected plants were liberated on healthy cardamom seedlings obtained from the Nelliampathy hills. The thrips freely laid eggs but the nymphs on hatching did not thrive and in a short time died out. No signs of the seedlings having taken the disease were evident after the lapse of three months.

Pests of moringa.

The moringa bud caterpillar (Noorda moringæ).—Studies on this new pest of moringa were continued. The caterpillars feed inside the buds and as a result of the attack the buds drop to the ground. The life cycle of the moth ranged from 19-28 days—the egg, larval and pupal periods being 3-4, 8-16 and 6-9 days, respectively. The caterpillars after four moults enter the soil for pupation. Infestation was not noticed in buds less than 4 mm. in size. The percentage of incidence of the pest in dropped buds is given below—April 1938 93.6; May 98.8; June 99.8; July 98.4; August 92.9; September 75.7; October 80.7; November 78.7; December 83.6 and January 1939 69.2. Spraying of Bordeaux mixture as a repellent did not give encouraging results. As the caterpillars pupate in the soil, raking up the soil round about trees was found to be effective.

Pests of jasmine.

The jasmine mite (Eriophyes sp.).—A tiny mite (*Eriophyes sp.*) was noted to produce woolly growth on jasmine leaves with the result that there was considerable reduction in the output of flowers. Experiments conducted during the season have shown that dusting flowers of sulphur was an effective remedy against the pest.

Pests of stored grains.

Experiments in connexion with storage of grains free from insects especially *Calandra oryzae* and *Rhizopertha dominica* by the use of certain substances mixed with grains were started in the Central Farm with paddy (Co. 6) and cholam (As. 809) grains stored in gunny bags. Eleven bags of each have been stored, each bag receiving a different treatment. The treatments are (1) 2 lb. of Acorus powder, (2) 2 lb. of Pyrethrum powder, (3) 2 lb. of Derris powder, (4) 2 lb. of Paracide, (5) 2 lb. of lime plus 2 oz. of creosote, (6) 5 lb. of neem leaves dried in the shade, (7) 5 lb. of pungam leaves, (8) 5 lb. of tulsi leaves, (9) talc powder, (10) drying of grains in the sun every month, and (11) control without any treatment. The experiments were started in December 1938 and every month 1 mm. of grain is taken at random from each bag and the insect population counted. The weight of grain in each bag at the beginning of the experiment has been taken and weight at the end of one year will be noted so as to find out the actual loss in each case. Though it is rather too early to assess the relative merits of the various treatments, the observations made so far go to show that sun drying is by far the best method while lime plus creosote, Paracide and Acorus have given fairly encouraging results.

A study was made of the underground storage of grains in the villages round about the Central Farm to note how far this would prevent insect damage. In these villages, cholam is stored in underground cellars having a comparatively narrow mouth covered over by planks or stone slabs and plastered with soil. Some of these cellars or pits are capable of holding 150 to 200 salagais or more. These are either circular or rectangular and their sizes vary according to the requirements of the ryots. This kind of storage is said to be useful only for cholam and ragi grains intended for *human consumption*. The grains intended for seed purposes are preserved in gunny bags or in wooden or masonry granaries inside houses. There is another system of pit storage of cholam grains prevalent in these villages where storage of small quantities, say, 50–75 salagais—and for a shorter period—about six months—is required. Circular pits are dug in which the grains are stored after a packing of cholam bran or empty earheads is given at the bottom and all round. On the top of the grain a gunny is spread over and again a layer of bran or chaff is put and the whole thing is covered over with soil. The efficacy of the different methods of storage against insect pests is being studied.

Insecticidal trials.—The following insecticides were received from various firms and tried against insect pests:—Multicide, Cowan's white ant exterminator, Vesfume, Vespra, Malariol, talc powder and *Tephrosia vogelli*, extracts of *Diospyros montana* bark and *Randia dumacoram* leaves and ACME all round spray.

Cuttings of *Derris elliptica*—an insecticidal plant were received from the Mysore Entomologist and planted at the insectary. A few cuttings were sent to the Agricultural Research Station, Palur, for trials there.

Chemotropic response of insects.

Field experiments conducted during the year included trials with substances such as Citronella oil, vinegar, toddy, molasses, acetic acid, etc. The chemicals were exposed in Minnestota traps and the insects collected so far included fruit flies, chalcids, beetles, etc., and these are being sorted out for sending to the Imperial Institute of Entomology, London, for identification.

Electroculture.

The following insects were subjected to electroculture treatment with disappointing results:—

Coleoptera.—The rice weevil; Bruchids on pillipesara; the grapevine flea beetle; Tribolum beetles and the cotton stem weevil.

Rhynchota.—The sugarcane mealy bug; Coccids on agathi; the brinjal mealy bug; the cotton mealy bug; the brinjal lace-wings; aphids on cluster beans and aphids on cotton.

Lepidoptera.—The citrus caterpillar; the mango borer caterpillar and the pomegranate caterpillar borer.

Diptera.—The mango fruit fly and mosquito larvæ.

The plants with the insects on them were sparked for two to three minutes but the insects remained unaffected though the plants received the shock. In some case the insects themselves were sparked when they remained motionless for a few seconds but revived soon after.

VI. LIFE HISTORY STUDIES AND PEST CONTROL WORK AT HEADQUARTERS.

The more important of the insects whose life histories and habits were studied during the year at the insectary, are given below:—

- (1) The sugarcane internode borer—*Diatraea venosata*.
- (2) *Tetrastichus ayyari*—a pupal parasite of *D. Venosata*.
- (3) *Trichogramma minutum*—a larval parasite of *Argyria sticticraspis* and *D. venosata*.
- (4) Ber fruit flies (*Dacus correctus* and *Carpomyia vesuviana*).
- (5) The groundnut "surul" (*Stomopteryx nerteria*).
- (6) The groundnut earwig (*Euborella stali*).
- (7) Syrphid predator (*Syrphus confrator*) on woolly aphids.
- (8) Parasites of cotton bollworms (*Microbracon spp.*).
- (9) The cotton stem weevil parasite—*Spathius sp.* (wingless).
- (10) The moringa bud caterpillar (*Noorda moringae*).
- (11) The lesser wax moth (*Achroia grisella*).
- (12) The wax beetle (*Platylolium alvearium*).

Numerous insect pests found in the Central Farm and the breeding stations received attention during the year. The more important of these were *Epilachna* beetles; Aphids and Tingids on brinjals; thrips on chillies; thrips and aphids on roses; *Aulacophora* on cucurbits; *utethesia* on sunnhemp; *Saissetia* on cotton; *Papilio* on citrus; *Parasa* on mango and *Psyllids* on curry leaf plants.

VII. BEE-KEEPING.

"We should think in terms of agriculture combined with cottage industries. Unless we create a subsidiary occupation for every family in the village we cannot make agriculture pay" said the Hon'ble Mr. V. V. Giri, at the Agricultural College Day and Conference, 1939. One such industry which is gaining rapid popularity is *bee-keeping*. The apiary attached to the insectary maintained on an average about 40 colonies throughout the year for research as well as demonstration purposes.

Research on various aspects of bee-keeping was continued during the year. Studies on the flight activity of workers in response to pasturage and weather conditions showed considerable progress. The results of the studies for two honey flow seasons and one slack season are being tabulated. Observations on the bee enemies—the Tenebrionid wax beetle (*Platylolium alvearium*), the wax moth (*Galleria mellonella*) and the lesser wax moth (*Achroia grisella*)—were continued. A simple method of eliminating the wax moth caterpillars from stored combs by exposing the latter to a mild sun (temperature not exceeding 45° C.) for about fifteen minutes was devised by the section and proved to be quite efficient under South Indian conditions. The lesser wax moth was found to be parasitized by a Braconid and hence it did not assume a pest form. The wax beetle was controlled by cleaning the floor board periodically. Another aspect of study which showed some progress was the artificial granulation of honey. Samples of honey which did not granulate for some months were found to do so when subjected to low and ordinary temperatures on alternate days for a period of about one and a half months. It is now possible to cater to the taste of buyers who show preference to granulated honey. As a result of the studies of bee pasturage plants, the following have been added to the list already noted:—*Ipomoea Batatas* Poir, *Syzygium Jambolanum* D.C., *Wightianum* Wall, *Tridax procumbens*, L., *Morinda tinctoria* Roxb, *Albizzia odoratissima* Benth, *Zizyphus Xylopyrus* Willd and *Trichodesma indicum* R.Br. A study of the weight of pollen collected by bees from different sources was made during the year. Data have been gathered for maize, cholam, zinnia and *Peltophorum*. The effect of requeening the colonies is yet another item of research tried during the year. The progress of the requeened and control colonies is being watched. As per orders of Government, studies on the extraction and preservation of rock bee honey were started during the year. A honey press and honey strainer were devised by the section. Preliminary trials have indicated that the strainer is quite efficient since 90 per cent of the honey was found to drain out within three hours. A centrifugal extractor has also been designed and it is proposed to try the machine at the earliest opportunity.

The bee-keeping industry continued to gain rapid popularity among the public throughout the Presidency. Numerous enquiries for advice, appliances, and literature were received from various parts of the Presidency and other provinces and States in India and the demands were met as far as possible. Demonstrations in hiving wild colonies and in the management of apiaries were given in different centres and apicultural exhibits were sent to various shows and exhibitions.

The usual short course in bee-keeping was held in February. Fourteen students from various parts of the Presidency attended the course and were given a thorough training especially in the practical aspects of bee-keeping. In addition to the training given to the short course students, three Mycological Assistants, the Farm Superintendent of the Zamin of Kangudi and a maistri from the Hosur Cattle Farm received the necessary training. The annual "Honey Week" organized by the section during April 1938 on a Presidency basis gave a further stimulus for the spread of this cottage industry. A comb foundation machine has been obtained from America during the end of the year and it will now be possible to meet the demand for foundation sheets. The bulletin on "Bee-keeping" was revised during the year and the pamphlet on "Practical Hints on Bee-keeping" translated into Telugu. There is a great demand for these publications. An event of great importance is the sanction of a temporary scheme in bee-keeping for Chittoor district. A special staff—a trained worker and an assistant—joined duty by the middle of July 1938 and after some training at Coimbatore, toured over the whole of the district with the officer in charge of the apiary. Suitable centres were selected for starting work and a demonstration apiary was started at Kalroodpally near Panapakkam. As a result of the efficient work done by the staff there are at present 124 hives working in different parts of the district. It is hoped that similar schemes will be forthcoming in other districts of the Presidency as well.

VIII. ERI SILK-WORM REARING.

Eri worms were reared throughout the year for supplying eggs for rearers in different parts of the Presidency.

IX. FUMIGATION.

During the year, 100 lots including samples of seeds, live plants, cuttings, suckers, plant bulbs, plant tubers, etc., were received from various parties. They were examined and fumigated wherever necessary and pest-free certificates issued. These included (1) millets intended for despatch to London, Japan, New South Wales, Rhodesia, Brisbane, Baghdad, U.S.S.R. and Canada, (2) oil-seeds intended for despatch to Virginia, Japan, England, Uganda, Baghdad and Port Blair, (3) cotton seeds from the Cotton Specialist for despatch to Italy, Shanghai, Trinidad, Sicily, England, Leningrad, Transvaal, Pretoria and Tashkent and those received by him from Trinidad, Uganda and Brazil, (4) paddy seeds from the Paddy Specialist for despatch to South America, Ibadan, Nigeria,

Ceylon, Sierra Leone, Japan, Washington, Columbia, Sydney, Arakansas, British Guiana, Russia, Brazil and Nyasaland, and (5) miscellaneous items such as lily bulbs for despatch to England; jalap tubers to Curator, Kew Gardens; mango budwood and grafts to Manila in Philippines and Burma; betelvine cuttings to Ceylon; mango nuts and Papaya to Hawaii; banana suckers to Port Blair; ginger rhizomes to United States of Soviet Russia and jute seeds to Kenya.

About 500 books belonging to the library were fumigated against insect attack. The cotton laboratory and a large quantity of sorghum for the Millets Specialist and Geneticist were fumigated. Samples from 45 consignments of tamarind intended for despatch to Egypt from Madras port were examined by the Government Mycologist and myself from time to time and certificates issued. Sugar-cane setts were examined for the Government Sugarcane Expert for despatch to various experimental stations.

X. INSECT COLLECTIONS AND SYSTEMATIC STUDIES.

During the year under review, eight consignments of insects were sent for identification to the Imperial Institute of Entomology, London, and six to the Bureau of Entomology, Washington. In addition to these, small consignments were sent to Dr. Bromley of Stamford (United States of America), Dr. Gravely of Madras and to the Imperial Entomologist, New Delhi. Our thanks are due to all these authorities for help rendered by them.

Small lots of insects were identified by us for various parties including Entomological Assistants stationed in the districts. A few specimens of insects were sent to the Imperial Entomologist for his collections. Live Coccinellid beetles (*Chilocorus nigrinus*) were despatched to the Director of Agriculture, Seychelles, for breeding and liberation against scale pests of crops in the islands.

Specimens of insects reared at the insectary were classified and incorporated into the main collections. The mixed collections of Coleoptera and twelve families of Lepidoptera were sorted out as time permitted.

Systematic studies on Coccinellidae, Bruchidæ, Braconidæ, Ichneumonidæ, Chalcididæ and Acarina showed considerable progress. Some of the collections made during the year are new to our laboratory and a few new to science.

XI. PROPAGANDA AND CAMPAIGNS.

In addition to research, the members of the Entomological section—those at headquarters as well as in the districts—carried on propaganda work to make known the results of the researches to the ryots. In this way, they conducted demonstrations, organized campaigns and took part in exhibitions. Articles of entomological interest were prepared for radio talks. In the enforcement of the Pest Act, valuable services were rendered by the staff stationed in the districts. A short summary of the work of the Entomological Assistants in the districts is given below.

In the First Circle, the Entomological Assistant stationed at Samalkot, in addition to popularizing bee-keeping as a cottage industry, studied the silver shoot fly of paddy, the paddy root grubs and the cane borers. He was of great help in the successful operation of the Pest Act against the red hairy caterpillar in Tekkali and Narasannapet. The items taken up for demonstration included citrus bark eating caterpillars, lemon caterpillar, tobacco plant lice, brinjal *Epilachna* and pumpkin beetles.

In the Second Circle, the entomological work was done by the staff stationed at Cuddapah, Bellary and St. Thomas Mount. The more important pests attended to by the assistant at Cuddapah were aphids and *Arbela* on citrus, thrips on onions, mango hoppers, mango stem borer and citrus mites. The assistant stationed at Bellary attended to the following pests:—The red hairy caterpillar, the Deccan grasshopper, betelvine bug, jasmine bug, *Epilachna* on brinjals and aphids on lablab. At St. Thomas Mount, the Entomology Demonstrator spent a good deal of his time in bee-keeping work. He, along with the Mycology Demonstrator, examined samples of tamarind from consignments meant for export to Egypt. The more important insect pests dealt with by him included the coconut caterpillar, mango hopper, brinjal *Epilachna*, red hairy caterpillar, coconut beetle and the moringa hairy caterpillar.

In the Third Circle, the assistant stationed at Tinnevely did a good deal of propaganda work in bee-keeping and conducted experiments for the control of cardamom thrips and pomegranate caterpillar in addition to demonstrating methods of control for pests in the locality.

In the Fourth Circle, a good deal of work on bee-keeping was done by the Entomology Assistant in the earlier months of the year on the West Coast. The pests attended to by him included the mango hopper, the coconut caterpillar, the red hairy caterpillar, *Prodenia* on agathi and cane borers.

XII. SCIENTIFIC PAPERS PUBLISHED AND PREPARED.

A. The following papers which were prepared and submitted previously were published during the year:—

- (1) *Rhaconotus scirpophagae* Wlk.—A parasite of the sugarcane white moth borer (*Scirpophaga*)—by M. C. Cherian and P. Israel, published in the *Madras Agricultural Journal*, Volume XXVI, No. 4, April 1938.
- (2) *Semiothisa (Macaria) pervolgata* Wlk.—A Geometrid pest of Daincha (*Sesbania aculeata*)—by M. C. Cherian and B. Rangiah Pillai, published in the *Madras Agricultural Journal*, Volume XXVI, No. 5, May 1938.
- (3) *Brachymeria excarinata* Gahan (Family Chalcididae)—a pupal parasite of *Plutella maculipennis* Curtis in South India—by M. C. Cherian and Muhammad Basheer, published in the *Proceedings of the Indian Academy of Sciences*, Volume VII, No. 6, June 1938.

- (4) *Stenobracon deesæ* Cam (Hymn. Brac.).—A natural enemy of the moth-borers of sugarcane—by M. C. Cherian and P. Israel, published in the *Madras Agricultural Journal*, Volume XXVI, No. 6, June 1938.
 - (5) Mite (*Acarina*) pests of crops in South India and methods for their control—by M. C. Cherian, published in *Agriculture and Livestock in India*, Volume VIII, Part V, September 1938.
 - (6) The present status of bee-keeping in Madras and suggestions for its development—by M. C. Cherian and S. Ramachandran, published in the *Madras Agricultural Journal*, Volume XXVI, No. 9, September 1938.
 - (7) A note on *Metanastria hyrtaca* Cram.—By T. V. Subrahmanya Ayyar and K. P. Anantanarayana Ayyar, published in the *Journal of the Bombay Natural History Society*, Volume XL, No. 2, September 1938.
 - (8) *Tetrastichus sokolowskii* Kurdj (Family Eulophidæ)—A larval parasite of *Plutella maculipennis* in South India—by M. C. Cherian and Muhammad Basheer, published in the *Proceedings of the Indian Academy of Sciences*, Volume IX, No. 2, February 1939.
 - (9) Tobacco stems as a useful source of nicotine for insecticidal purposes—by M. C. Cherian and M. S. Kylasam, published in the *Madras Agricultural Journal*, Volume XXVII, No. 2, February 1939.
 - (10) Notes on the life history and habits of *Dacus brevistylus* Bezzi (Family Trypetidæ)—a pest of *Coccinia indica* fruits—by M. C. Cherian and C. V. Sundaram, published in the *Indian Journal of Agricultural Science*, Volume IX, Part I, February 1939.
 - (11) Notes on *Perina nuda* Fabr. (Lymnt. Lepid) and its natural enemies—by M. C. Cherian and P. Israel, published in the *Madras Agricultural Journal*, Volume XXVII, No. 6, June 1939.
 - (12) Studies on the coconut palm beetle (*Oryctes rhinoceros* Linn) in South India—by M. C. Cherian and K. P. Anantanarayanan, published in the *Indian Journal of Agricultural Science*, Volume IX, Part III, June 1939.
- B. The following papers were prepared during the year :—
- (1) The control of the rice grasshopper (*Hieroglyphus banian* Fabr.) in South India—by Y. Ramachandra Rao and M. C. Cherian.
 - (2) A new caterpillar pest of moringa in South India—*Noorda moringae* Tams—by M. C. Cherian and Muhammad Basheer.
 - (3) A Bethyloid natural enemy of the sugarcane white moth borer—by M. C. Cherian and P. Israel.

- (4) A caterpillar pest of grasses in South India—by M. C. Cherian and K. P. Anantanarayanan.
- (5) Further studies on the cholam earhead bug (*Calocoris angustatus*) in South India—by M. C. Cherian, M. S. Kylesam and P. S. Krishnamurthy.
- (6) *Achroia grisella* and its status in South India—by M. C. Cherian and S. Ramachandran.
- (7) Further studies on the control of *Laphygma exigua*—a pest of tobacco nurseries—by M. C. Cherian and M. S. Kylesam.
- (8) Some factors affecting plant resistance to insect pests—by P. N. Krishna Ayyar.

Of the eight papers mentioned above, the first five were presented at the Agricultural Section of the Indian Science Congress held at Lahore in January 1939.

XIII. ARTISTS' SECTION.

The Artists' section continued to be in my charge throughout the period under report. The following items of work were attended to :—black and white drawings 51 ; plans, maps and graphs 462 ; colour paintings and posters 558 ; labels 842 ; descriptive posters 110 ; photographs 933 ; micro photo 247 ; prints 4,105 ; enlargements 384 and lantern slides 453.

XIV. MISCELLANEOUS.

Sectional meetings.—The monthly meetings of the scientific staff of the section at which papers were read and articles reviewed, were of great help in bringing together the different members for discussion of various scientific problems.

University Examination in Agriculture.—I acted as Examiner in Zoology and Sri K. P. Anantanarayana Ayyar in Agricultural Zoology for 1938. Sri T. V. Subrahmanya Ayyar acted as Internal Examiner in both the subjects.

Entomological meeting at New Delhi.—I visited New Delhi in May 1938, in connexion with the meeting of the Entomologists convened by the Imperial Council of Agricultural Research when the scheme for the sugarcane borer survey in the various parts of India including the Madras Presidency was discussed. A special staff at Anakapalle and Gudiyattam was sanctioned and work begun in March 1939.

Training in Entomology.—As a result of the redistribution of Entomological and Mycological Demonstrators in the districts, three of the district staff in Mycology were each given training in Entomology for three months. As permitted by the Director of Agriculture, Sri G. K. Ratnaswami, B.Sc., was admitted for post-graduate work in Entomology.

COIMBATORE,
6th August 1939.

M. C. CHERIAN,
Government Entomologist.

DETAILED ADMINISTRATION REPORT OF THE GOVERNMENT MYCOLOGIST FOR THE YEAR 1938-39.

I was in charge of the Mycological section and the Microtome section throughout the year.

The activities of the section are classified under the following main heads :—

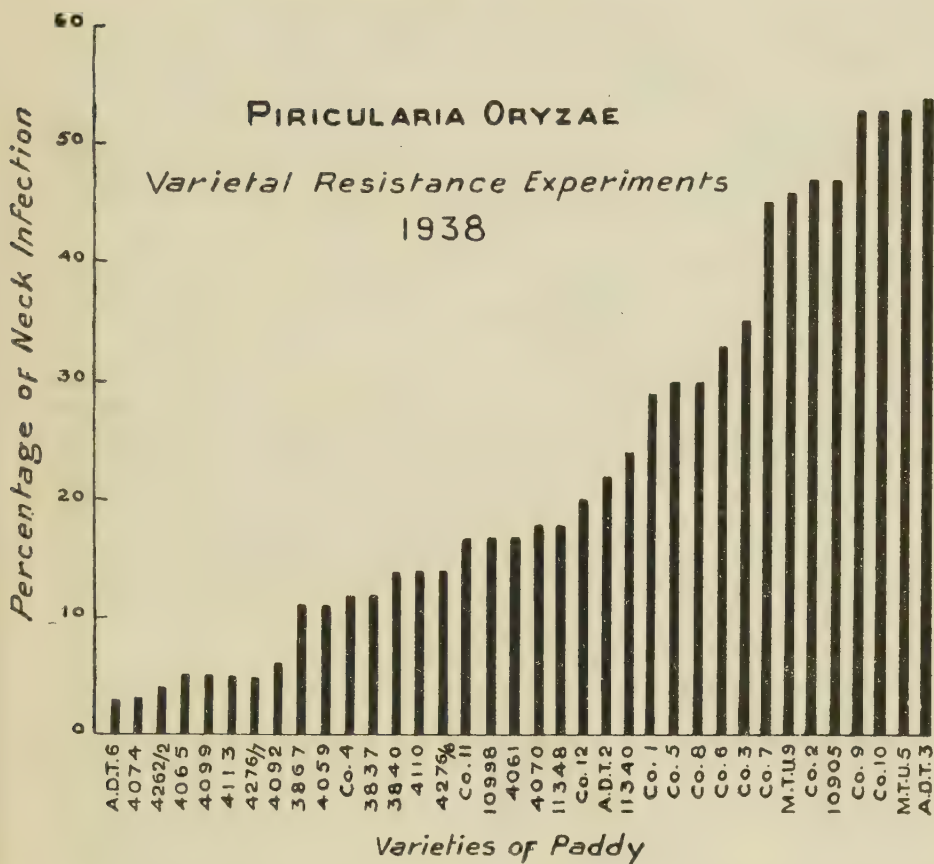
- (i) Mycological Research.
- (ii) Virus disease investigations.
- (iii) Advisory work.
- (iv) Quarantine service.
- (v) Legislative measures.
- (vi) Propaganda.
- (vii) Teaching.
- (viii) Microtomy.

I. MYCOLOGICAL RESEARCH.

The following are the main items of research :—

1. *Paddy*—' *Blast* '—*Piricularia oryzae*.

(a) *Studies in varietal resistance*.—Thirty-six strains of paddy consisting of seventeen departmental strains, viz., Co. 1 to 12, Adt 2, 3 and 6, Mtu 5 and 9, and 19 new strains supplied by the Paddy Specialist were taken up for studying their relative resistance to *Piricularia* under field conditions in Coimbatore Central Farm. These varieties were planted in rows alternating with Adt 10, a variety which has been consistently found to be very susceptible in previous experiments. The belt of outskirts also consisted of the susceptible Adt 10, so that the experimental strains may be exposed to heavy infection. Periodical observations were made and the amount of leaf, node and neck infection for these thirty-six varieties were noted down. These observations were continued till the time of harvest. The following graph gives the degree of infection in each strain based on the counts of neck attack :—



Of the departmental strains, Co 2, 7, 9 and 10; Adt 3; and Mtu 5 and 9 were found to be the most susceptible while Adt 6 was found to be the most resistant. Co 4 and Co 11 which were hitherto considered resistant gave respectively 12 and 17 per cent infection.

(b) *Effect of disease on yield in relation to period of sowing.*—Monthly sowings were done from September to November with ten departmental strains. These were also sown in rows inter-stripped with Adt 10. Records of observations on the amount of leaf, node and neck infections were maintained till harvest. Based on September planting which gave the highest amount of neck infection, the ranking of these varieties in the order of their susceptibility is given in the statement below:—

Name of variety.	Percentage of infection (neck attack).	Name of variety.	Percentage of infection (neck attack).
Co 9	65	Co 2	14
Adt 3	47	Co 4	14
Mtu 9	27	Co 5	11
Mtu 5	19	Co 7	11
Co 11	17	Adt 6	4

In this experiment also Adt 6 is found to be the most resistant strain.

Later plantings suffered less than the earlier plantings.

In September planting, the late flowering varieties suffered less than the early flowering varieties. This is in conformity with the results obtained last year for August plantings.

(c) *Susceptibility of G.E.B. 24 to Piricularia infection.*—This variety was hitherto considered as resistant to *Piricularia*. Heavy infection was however noticed during the year in the Central Farm as well as the Paddy breeding station. Records of neck infection taken in both the places show that the infection at the Paddy breeding station was as high as 49 per cent and the infection at the central farm 32 per cent. The disease was found to be severe in patches where the plants showed rank vegetative growth. The average height of these affected plants was found to be 49.13 inches whereas the normal uninfected plants was found to have an average height of only 27.78 inches. The stomata from leaves of the abnormally grown plants were found to be bigger than those of normal plants.

(d) *Viability studies.*—Diseased material consisting of necks and nodes of Adt 10 was collected in March 1938 and stored in (1) pulverized paddy soil, (2) pulverized farm-yard manure and (3) dry blotting paper. A portion of the diseased material in each sample was cultured every month to find out the viability of the organism under the above storage conditions. The organism in all these three samples was found to be viable up to thirteen months.

2. *Helminthosporiose of cereals—wheat, ragi and paddy.*

The study of the *Helminthosporium spp.* isolated from wheat, ragi and paddy was continued. As the strain isolated from paddy was found to differ from *H. oryzae* in its characteristics, a pure culture of the strain was sent to the Imperial Bureau of Mycology for identification. As surmised it was found to be entirely different from *H. oryzae* and was identified as *H. tetramera*. Another isolation was therefore made from *Helminthosporium*-infected seedlings and the new isolation was found to conform to the characteristics of *H. oryzae*.

(a) *Comparative study of H. tetramera and H. oryzae*—*H. tetramera* was found to be morphologically and physiologically different from *H. oryzae* and was found to have much smaller conidia than *H. oryzae*. *H. tetramera* was also found to sporulate freely and copiously in all the usual laboratory media while *H. oryzae* was found to sporulate only sparingly under identical conditions. *H. tetramera* also failed to produce any infection on leaves, stems and ear-heads when inoculated, whereas in the case of *H. oryzae* the infection was evident within 48 hours and gave cent. per cent. infection.

(b) *Study of the growth of H. tetramera and H. oryzae* was made in media containing different ratios of carbon and nitrogen. The following tabular statement gives the results obtained :—

Statement showing the growth per day of H. tetramera and H. oryzae in media with different carbon/nitrogen ratios.

C/N. ratio.				H. oryzae.	H. tetramera.
				mm.	mm.
5/1	..	..	..	9.27	6.32
2/1	..	..	..	9.03	6.34
1/1	..	..	..	7.23	5.80
1/2	..	..	..	7.00	5.65
1/5	..	..	..	5.55	..

A higher carbon/nitrogen ratio is found to give a better growth than the lower ratio in the case of both the strains. The rate of growth in *H. oryzae* is greater than in the case of *H. tetramera*.

(c) *Study of H. tetramera*.—The growth of this organism in liquid media with different sources of nitrogen was determined by taking the dry weight of the mycelial mats in each of the series of nitrogen. The following table gives the results obtained :—

Average weight of dry mycelial mat of H. tetramera in liquid media with different sources of nitrogen.

Source of nitrogen.				pH. value.		Weight of dry mycelial mat in. mgm.
				Initial.	Final.	
Asparagin	..	..		4.80	8.00	323.6
Peptone	..	..		6.20	8.10	373.5
Urea	..	..		8.00	7.40	318.0
KNO ₃	..	..	..	5.20	7.80	285.6
KNO ₃	..	..	..	7.20	8.00	271.2
(NH ₄) No	..	..		5.00	2.80	138.0
(NH ₄) ₂ So ₄	..	..		4.90	2.80	152.3

The results obtained in this experiment are found to be in conformity with the linear growth rate obtained on solid media with the same sources of nitrogen. The study of the initial and final pH values shows that when ammoniacal sources of nitrogen are used, the medium becomes extremely acid.

(d) *Study of H. oryzae*.—Flasks each with 100 c.c. of Waksman's solution were inoculated with *H. oryzae*. From the tenth day onwards, the pH of the solution and the dry weight of mycelial mats were taken at intervals up to four weeks from the date of inoculation. The results are tabulated in the statement below :—

Period of growth, days.					pH. values.		Weight of dry mat mgm.
					Initial.	Final.	
10	..	..	..	..	6.20	6.60	484.1
14	..	..	..	..	6.20	8.10	432.2
18	..	..	..	..	6.20	8.20	416.4
22	..	..	..	..	6.20	8.20	398.5
26	..	..	..	..	6.20	8.20	395.8

The reduction in weight from the tenth day is apparently due to autolysis.

Growth of H. oryzae in solid and liquid media at different temperatures.—The statement below gives the results obtained :—

Temperature.				Average growth per day.	Weight of mycelium in 100 cc. of liquid medium.
				mm.	mgm.
5°C	..	..	..	..	17.8
10°C	..	..	..	2.89	247.2
15°C	..	..	..	6.75	334.5
22°C	..	..	..	9.69	424.1
26.5°C	..	..	..	12.76	425.6
30°C	..	..	..	13.04	455.4
33.5°C	..	..	..	9.89	..
36.5°C	..	..	..	nil.	..

It is seen from the results that the growth at 5°C is slow and poor while the growth at 36.5°C is completely retarded. This was found from the fact that when these plates were again incubated at 26.5°C, the organism began to grow very well. This shows that the organism had not been killed at this temperature though there was no growth. The optimum temperature for the growth of *H. oryzae* is found to be near 30 C.

(e) *Comparative study of Helminthosporium tetramera, H. nodulosum and H. sativum.*—(i) *Parasitism.*—Seed infection experiments were conducted by soaking the seeds in spore suspensions of each strain and then sowing them in germination trays. The results of these seed infection experiments are given in the statement below :—

Seeds used.		Strain of fungus.		Number of seeds sown.	Percentage of germination.	Percentage of infection.
Wheat	..	Wheat	Helminthosporium.	50	92	83
Ragi	..	..	Do.	50	94	45
Paddy	..	..	Do.	50	94	32
Wheat	..	Ragi	Helminthosporium.	50	90	40
Ragi	..	..	Do.	50	96	85
Paddy	..	..	Do.	50	92	31
Wheat	..	..	<i>H. tetramera</i>	50	90	36
Ragi	..	..	Do.	50	88	25
Paddy	..	..	Do.	50	94	74

Each strain is found to give a high percentage of infection only in the case of the host from which it has been isolated. The other hosts however have not been found to be completely immune.

Soil infection experiments with *H. tetramera* did not produce any infection of the paddy seedlings.

Cross inoculations on seedlings.—Barley, oats, wheat, cholam, cumbu, ragi, tenai and maize seedlings were inoculated with *H. tetramera*, *H. nodulosum* and wheat *Helminthosporium*. The following conclusions are drawn from this experiment :—

- (1) *H. tetramera* failed to infect any of these seedlings.
- (2) *Helminthosporium* spp. from ragi and wheat were found to infect seedlings of barley, oats, wheat, cumbu, ragi, tenai and maize.
- (3) Cholam seedlings were not infected by any of these three strains.

Cross inoculations on leaves and earheads.—The following results were obtained from these inoculations :—

- (1) *H. tetramera* failed to infect leaves and earheads of ragi and wheat.
- (2) Ragi strain is able to infect both ragi and wheat.
- (3) Wheat strain also is found to infect both wheat and ragi.

(ii) *Physiological studies*—*Growth in different sources of nitrogen.*—The average linear rate of growth per day was determined for the three species of *Helminthosporium* when grown on solid media with different sources of nitrogen. Waksman's medium without peptone was used as the basic medium to which the following sources of nitrogen were added : (i) ammoniacal nitrogen—ammonium chloride and ammonium sulphate ; (ii) nitrite nitrogen—potassium nitrite and sodium nitrite ; (iii) nitrate nitrogen—calcium nitrate, potassium nitrate and sodium nitrate ; (iv) organic nitrogen—asparagin, peptone and urea. The tabular statement below gives the growth obtained at 28°C for each of the three species of *Helminthosporium* for the various sources of nitrogen used.

Average linear rate of growth per day at 28°—29°C.

Nitrogen source.		H. nodulosum.	Wheat	H. tetramera.
			Helminthosporium.	
		m.m.	m.m.	m.m.
Ammonium chloride	.. ..	4.16	2.32	2.04
Ammonium sulphate	.. ..	4.08	1.97	2.13
Pot. nitrite	.. ..	7.64	6.88	4.37
Sod. nitrite	.. ..	7.97	6.57	4.07
Cal. nitrate	.. ..	9.13	9.94	4.21
Pot. nitrate	.. ..	10.46	10.15	5.16
Sod. nitrate	.. ..	10.52	10.36	4.86
Asparagin	.. ..	9.46	8.58	5.78
Peptone	.. ..	9.55	8.68	5.64
Urea	.. ..	7.99	6.08	5.26
Control	.. ..	9.41	9.25	5.87

The results indicate that *H. tetramera* grows best in organic nitrogen while the ragi and wheat strains do well in nitrate nitrogen. The growth of all the three species is uniformly poor in ammoniacal nitrogen.

Growth of the three species of Helminthosporium in relation to various temperatures.—The following tabular statement gives the rate of growth obtained per day for the *Helminthosporium* spp. studied :—

Average linear rate of growth per day in mm.

Temperature.	<i>H. tetramera</i>	<i>H. nodulosum.</i>	Wheat <i>Helminthosporium.</i>
15.5°C	2.07	3.50	3.12
21.5°C	3.44	6.78	6.16
26.5°C	5.23	8.70	8.14
30.5°C	5.48	8.73	8.18
33.5°C	4.28	6.75	..
36.5°C	2.92	4.85	nil.

As a result of this study it is seen that the optimum temperature for the growth of all these three strains is the same, viz., 30.5°C. While *H. tetramera* and *H. nodulosum* are able to grow at 36.5°C., the growth of wheat *Helminthosporium* is found to be completely checked. The wheat strain, however, was not killed at 37°C. as the inoculum began to grow when brought to 31°C. Ragi *Helminthosporium* showed more rapid growth than the other two species at all the temperatures studied.

Zonation in the growth of Helminthosporium.—Plates inoculated with the three strains of *Helminthosporium* were kept in complete darkness. No zonation was found in the growth in any of these plates. The plates which were however exposed to daylight and darkness in the nights showed zonation thus indicating that zonation in these strains was due to the exposure to light during day time and darkness during nights.

3. *Areca palm*—*Mahali* (*Phytophthora arecæ*).

The study of this disease was continued.

Field experiments on control.—Extensive field experiments involving 10 treatments were carried out in South Kanara. These experiments were laid down with a view to gain further knowledge on the following aspects of control and gain additional information on the findings of last year :—

- (1) The relative merits of 2 per cent and 1 per cent Bordeaux mixture.
- (2) The relative advantages of different stickers and spreaders added to Bordeaux mixture.
- (3) The relative efficiency of jet spraying and mist spraying. This point had to be taken into consideration as jet spraying has become a very common practice in spraying areca trees.

The following tabular statement gives the details of the treatments tried :—

Strength of Bordeaux mixture, PER CENT.	Adhesive per 100 gallons.	Nature of spray.	Amount of nutfall.
2	Resin 8 lb.	Mist.	..
1	Do.	Do.	9
2	Resin 2 lb.	Do.	..
2	Casein 2 lb.	Do.	1
1	Do.	Do.	9
2	Niger oil- $\frac{1}{2}$ gallon.	Do.	6
2	Do.	Jet.	9
1	Do.	Mist.	19
2	No adhesive.	Do.	2
Control.	....	Do.	13

Though the first signs of disease appeared early in the experimental plots, it did not spread sufficiently to yield definite results.

As the results obtained during the first year of the experiments could not be confirmed during the second year of the experiment, it was thought desirable to continue the experiment during the year 1939-40. Four gardens were selected in four different villages in Puthur taluk of South Kanara. In each of these gardens, 150 trees were selected for the experiment except in one garden where only 120 trees were selected. The results of these experiments are awaited. The following tabular statement shows the treatment given in each garden :—

S. No.	Mixture used.	Strength of mixture. PER CENT.	Adhesive used.	Quantity of adhesive used.	Kind of spray, mist or jet.
1	Bordeaux mixture.	2	Resin.	8 lb. per 100 gallons.	Mist.
2	Do.	1	Do.	Do.	Do.
3	Do.	2	Do.	2 lb. per 100 gallons.	Do.
4	Do.	2	Casein.	Do.	Do.
5	Do.	1	Do.	Do.	Do.
6	Do.	2	Niger oil.	Do.	Do.
7	Do.	2	Do.	$\frac{1}{2}$ gallon per 100 gallons.	Jet.
8	Do.	1	Do.	Do.	Mist.
9	Do.	2	No adhesive.	No adhesive.	Do.
10	Control.	..	..	..	Do.

Laboratory studies.

(a) *Comparative rate of growth of areca, palmyra, citrus and tobacco Phytophthoras at different temperatures.*—The four isolations of *Phytophthora* were inoculated in Petri dishes containing Merlich's medium of pH. 5.33 and incubated at 5°C., 10°C., 15°C., 20°C., 25°C., 30°C., and 35°C. The following tabular statement gives the average rate of growth :—

Strain of Phytophthora.	Rate of linear growth per day at						
	5 C	10 C	15 C	20 C	25 C	30 C	35 C
Tobacco ..	No growth	Slight	0.83 mm	1.48 mm	..	2.56 mm	Nil.
Areca ..	Do.	Do.	2.02 mm	3.93 mm	6.40 mm	7.27 mm	Do.
Palmyra ..	Do.	No growth	2.91 mm	5.77 mm	6.14 mm	6.64 mm	Do.
Citrus ..	Do.	Slight	4.43 mm	5.62 mm	6.52 mm	7.14 mm	Do.

Conclusions.—(1) None of these *Phytophthora* strains shows any growth at 5°C and 35°C.

(2) Palmyra strain does not show any growth at 10°C.

(3) The optimum temperature for all these four strains is found to be near 30°C.

(4) The order of growth at this temperature is as follows :—
(1) areca, (2) citrus, (3) palmyra, (4) tobacco.

Nature of growth.—Palmyra *Phytophthora* is the only one that showed aerial growth. All the others showed only submerged growth.

(b) *Study of the effect of humidity on the growth of Phytophthora strains.*—Petri dishes with Merlich's medium were inoculated with areca, citrus, and palmyra *Phytophthoras*. The inoculated plates were incubated in chambers with the following relative humidities :—100 per cent, 95 per cent, 84 per cent, 75 per cent, 66 per cent, 52 per cent. The average rate of growth per day for each *Phytophthora* under the various humidities are given in the tabular statement below :—

Strain of <i>Phytophthora</i> .	Percentage of relative humidity.					
	Average rate of growth per day in mm.					
	100	95	84	75	66	52
Citrus	6.90	8.22	7.53	8.69	6.53	7.81
Areca	7.44	4.94	7.03	7.00	5.31	6.50
Palmyra	6.94	7.54	6.59	7.31	5.78	6.40

In the case of palmyra *Phytophthora*, the optimum growth is at 95 per cent relative humidity. The growth in the other *Phytophthoras* are found to be varying.

(c) *Utilization of starch by Phytophthora spp.*—The four fungi were grown in Petri dishes on Macbeth and Scale's starch agar. They were allowed to grow for seven days and the plates were then flooded with dilute iodine solution. The portions where the colonies had grown remained unaffected thus demonstrating the digestion of starch by the enzyme diastase secreted by the *Phytophthora* strains used.

The growth of the citrus *Phytophthora* was about twice as much as the other *Phytophthoras*.

(d) *Study of the digestion of sugars by Phytophthora strains.*—Broths consisting of 2 per cent peptone and 2 per cent dextrose, sucrose or lactose were made up and inoculated with areca, palmyra, citrus and tobacco *Phytophthoras*. One portion consisting of 2 per cent peptone alone was inoculated as control. 200 c.c. of broth was used for each flask; the digestion of these sugars was determined by the change in pH after seven days.

The following tabular statement gives the details of the change in pH. :—

Areca Phytophthora.

Broths used.	Initial pH.	Final pH.	Change in pH.
Peptone	7.0	7.0	Nil.
Peptone and lactose	6.8	6.8	"
Peptone and dextrose	6.4	4.4	2.0
Peptone and sucrose	6.8	4.4	2.4

Palmyra Phytophthora.

Broths used.	Initial pH.	Final pH.	Change in pH.
Peptone	7.0	7.0	Nil.
Peptone and lactose	6.8	6.8	"
Peptone and dextrose	6.4	4.8	1.6
Peptone and sucrose	6.8	4.8	2.0

Citrus Phytophthora.

Broths used.	Initial pH.	Final pH.	Change in pH.
Peptone	7.0	7.0	Nil.
Peptone and lactose	6.8	6.8	"
Peptone and dextrose	6.2	4.5	1.7
Peptone and sucrose	6.8	4.9	1.9

Tobacco Phytophthora.

Broths used.	Initial pH.	Final pH.	Change in pH.
Peptone	6.9	6.9	Nil.
Peptone and lactose	6.5	6.5	"
Peptone and dextrose	6.2	5.6	0.6
Peptone and sucrose	6.8	5.7	1.1

In *dextrose* the change in pH induced by the four strains of *Phytophthora* was 2.0, 1.6, 1.7 and 0.6, respectively, thus showing that this sugar is digested. The digestion of dextrose necessitates the production of zymase. The maximum production is found to be by *areca Phytophthora* and the least in the case of *tobacco Phytophthora*.

In *sucrose* the change in pH was 2.4, 2.0, 1.9 and 1.1, respectively, thus demonstrating the production of invertase. In this series also the maximum amount of invertase is found in the case of *areca Phytophthora* and least in *tobacco Phytophthora*.

In *lactose* there was no change in pH thus showing that the organisms were not able to utilize it.

(e) *Growth of areca, palmyra, citrus and tobacco Phytophthoras with different sources of nitrogen.*—Six sources of nitrogen—peptone, urea, asparagin, potassium nitrate, potassium nitrite and ammonium sulphate were added to a basic medium and the four fungi grown in Petri dishes. The growth in each plate was marked and the average rate of growth per day was calculated. The following tabular statement gives the average rate of growth per day in each of these six sources of nitrogen :—

Average rate of growth per day in mm. with different sources of nitrogen.

Strains of <i>Phytophthora.</i>	Peptone.	Potassium nitrate.	Asparagin.	Ammonium sulphate.	Urea	Potassium nitrite.
<i>Citrus</i> ..	8.23	7.58	6.25	3.38	Slight.	No growth.
<i>Palmyra</i> ..	8.07	8.86	9.54	3.14	Do.	Do.
<i>Areca</i> ..	10.88	4.83	3.71	Slight.	Do.	Do.
<i>Tobacco</i> ..	3.40	4.94	5.42	1.83	4.83	Do.

Peptone gives the best growth for citrus and areca *Phytophthoras*. *Asparagin* gives the best growth for palmyra and tobacco. The most interesting point is that tobacco *Phytophthora* was the only organism that was able to grow well in urea.

(f) *Action of Trichoderma lignorum on Phytophthora spp.*—Oatmeal agar plates were inoculated with *Trichoderma lignorum* near one end and a *Phytophthora* sp. near the opposite end. *Phytophthora* spp. isolated from areca, palmyra, citrus, tobacco and betelvine were used. In each plate both the *Trichoderma* and the *Phytophthora* strain grew well until they met and then the *Trichoderma* was found to overrun the entire plate. Just at the point of contact before *Trichoderma* grew over, the *Phytophthora* mycelium in contact with *Trichoderma* were examined. In no case it has been possible to find any penetration of *Trichoderma* hyphæ, either into the hyphæ, sporangia or chlamydospores of the *Phytophthora* species tried. A few of them, however, showed disintegration and loss of contents. Three days later, the plates were entirely covered over by *Trichoderma* and the *Phytophthora* growth was found to be completely disintegrated.

(g) *Cross inoculation with areca, palmyra, citrus and tobacco Phytophthoras.*—The following conclusions were drawn from the inoculation studies :—

Inoculations with areca and palmyra strains.

1. *Arecanuts.*—Areca *Phytophthora* was found to infect 2-month and 4-month old nuts and not 6-month old nuts whereas palmyra *Phytophthora* was found to infect 2-month old nuts only.

2. *Brinjal fruits.*—*Phytophthora palmivora* was found to infect wounded and unwounded brinjal fruits whereas areca *Phytophthora* did not cause any infection.

3. *Tomato fruits.*—Both *Phytophthoras* did not infect wounded or unwounded green tomato fruits. Even unwounded ripe fruits were not infected.

4. *Stems of chilli and brinjal seedlings.*—Both these fungi did not infect either stems of chillies or brinjals, wounded as well as unwounded or the unwounded growing points.

Inoculations with areca, palmyra, citrus and tobacco Phytophthoras.

Castor seedlings.—Of these four strains, *palmivora* is more virulently pathogenic than the others. Tobacco, areca and citrus strains are alike in their behaviour. On unwounded growing points, the fungi did not produce any infection.

Potato tubers.—On wounded tubers, areca and tobacco strains were found to be more virulent than citrus and palmyra strains. Between palmyra and citrus strains, palmyra strain is more virulent than the citrus strain. All the tubers were finally cut and exposed to the air for about half an hour. The infected portions turned to a pink colour after the exposure while the control tubers remained white.

Tomato seedlings.—None of these Phytophthoras produced any infection when inoculated $\frac{1}{2}$ inch above soil level even in the case of wound inoculations.

Apple fruits.—All the four strains of Phytophthora readily infect wounded apple fruits. All the four strains are able to cause wound infection, the areca strain giving the maximum spread. Unwounded fruits did not take infection.

Colocasia leaves.—Inoculations on wounded colocasia leaves by the four strains did not produce any infection.

Fruits of citrus.—All the four strains of Phytophthora are able to infect wounded fruits of *Citrus nobilis*. Citrus Phytophthora was the only organism that was able to infect wounded fruits of *Citrus sinensis*.

Fruits of Artocarpus incisa.—All the four strains are found to infect unwounded bread-fruits in seven days. The palmyra strain was found to be more virulent than the others.

On papaya seedlings at the collar regions.—Both wounded and unwounded inoculations at the collar did not produce infection by any one of these four strains.

4. *Gloeosporium disease of arecanuts.*

As the spraying experiments laid out in Semmedu in January 1938 had not given any conclusive results, it was decided to lay out manurial trials in combination with spraying for the control of the disease.

Ninty-six trees were selected and divided into twelve randomized plots of eight trees each. Three plots were taken for each of the following treatments :—

- (1) Application of super phosphate at the rate of $\frac{1}{2}$ lb. per tree.
- (2) Application of sulphate of potash at the rate of $\frac{1}{2}$ lb. per tree.
- (3) Control.

Besides the manurial treatments, half the number of trees in each plot was sprayed with $\frac{1}{2}$ per cent oil Bordeaux mixture. The observations are being recorded.

5. *Chilli wilt—Fusarium vasinfectum.*

Field experiments on control.—A field experiment was laid out to find the effect of the following treatments on the incidence of chilli wilt :—

- (1) Application of sulphur to the soil at the rate of 500 lb. per acre.
- (2) Application of 0.1 per cent solution of copper sulphate to the soil at the rate of 50 lb. per acre.

(3) Application of 1 per cent acid Bordeaux mixture to the soil at the rate of 1,380 gallons per acre.

(4) Application to the soil of culture of *Trichoderma lignorum* mixed with cattle manure.

As the incidence of wilt was very low even in the control plots, it was not possible to base any definite conclusions as a result of this experiment.

6. Horsegram wilt—*Macrophomina phaseoli*.

Germinating seeds transferred to soil inoculated with *Macrophomina phaseoli* were found to give only a small percentage of infection. With a view to find the best method of inoculation for getting a high percentage of infection, a number of methods were tried. From these trials, it was found that inoculation of the radicle of germinating seedlings and then transferring them to soil gave 50 per cent to 66 per cent of infection whereas by other methods it was possible to get only 17 to 33 per cent infection.

Effect of infection on the growth of roots.—Inoculated seedlings of horsegram plants were transferred to soil in specially made root observation boxes for studying the root system of inoculated and uninoculated control seedlings. The length of the root system of healthy seedlings is from 8.7 to 13.7 inches whereas in the case of infected seedlings it is found to be only 1.5 to 2.85 inches.

Temperature relations.—The growth of the fungus was found to be best at about 37°C as shown in the following table :—

Growth of M. phaseoli at various temperatures in potato dextrose agar.

Temperature.				Average daily growth in cm.
8°C	..	..	..	0.14
16°C	..	..	..	1.35
22°C	..	..	..	1.90
25°C	..	..	..	2.60
29°C	..	..	..	3.00
31°C	..	..	..	3.19
37°C	..	..	..	3.40

It will be seen from the above statement that between 8 to 37°C the growth rate increases with increased temperature. The most noteworthy feature about this organism is that its optimum growth is at a temperature unusual for fungi.

Pathogenicity of Macrophomina phaseoli in the presence of Trichoderma lignorum.—In order to test the pathogenicity of *M. phaseoli* with and without the presence of *Trichoderma lignorum*, the following inoculations were carried out on two-day old seedlings raised on moist cotton wool in potato tubes :—

- (1) Inoculations with *M. phaseoli*.
- (2) Inoculations with *Trichoderma*.
- (3) Inoculations with a mixture *M. phaseoli* and *T. lignorum*.
- (4) Control.

Of the three series of inoculations, infection was found only when *Macrophomina* alone was inoculated. This shows that the parasitic activity of *M. phaseoli* is completely checked in the presence of *Trichoderma*.

Toxicity of filtrate of Trichoderma lignorum.—Addition of 10 per cent of filtrate from liquid cultures of *Trichoderma lignorum* to other nutrient media was found to retard the growth of *M. phaseoli*.

7. Field experiments on groundnut—Wilt—(*Macrophomina phaseoli*).

The following scheme of experiments for the control of *Macrophomina* wilt in the irrigated crop of groundnut was laid out in the Agricultural Research Station, Tindivanam :—

- (1) Seed dressing with ceresan at 1 gm. per lb. of seed.
- (2) Application of sulphur to the soil at 200 lb. per acre.
- (3) Application of cattle manure at 10,000 lb. per acre.
- (4) Spraying the soil with a spore suspension of *Trichoderma lignorum*.
- (5) Mixing seed with conidia of *Trichoderma lignorum*.
- (6) Application of slaked lime at 1,000 lb. per acre.
- (7) Application of potassium sulphate at 400 lb. per acre.
- (8) Control—no treatment.

The results of these trials are being recorded.

8. Ragi blast—*Piricularia* sp.

Study of varietal resistance.—The following fifteen varieties of ragi seeds kindly supplied by the Millets Specialist and Geneticist were tested for their resistance to *Piricularia*: (1) E.C 24, (2) E.C 47, (3) E.C 155, (4) E.C 297, (5) E.C 560, (6) E.C 593, (7) E.C 1000, (8) E.C 1507, (9) E.C 1540, (10) E.C 2553, (11) E.C 2985, (12) E.C 3030, (13) E.C 3517, (14) E.C 3735 and (15) M.S 4439.

Seedlings were raised from these seeds and inoculations were conducted with the *Piricularia* culture on seedlings one to seven weeks old. The results showed that none of the ragi strains was absolutely resistant. Heavy infection was obtained especially in one to two weeks old seedlings.

Twelve varieties were also put under field trials for ascertaining their resistance or susceptibility under natural field conditions. Monthly sowings of these varieties were done in order to find out the incidence of the disease in relation to the time of sowing. The results of these field experiments are awaited.

Cross inoculations with Ragi piricularia.—(1) Inoculated Korangu samba seedlings failed to take infection thus showing that the fungus is different from *Piricularia oryzae*.

(2) Young seedlings of wheat, barley and oats were found to take infection quite readily.

(3) Ginger plants failed to take infection thus indicating that the ragi *Piricularia* is different from *Piricularia zingiberi*.

Growth of Ragi Piricularia in relation to the H-ion concentration of media.—The fungus was grown in Czapek's agar and ragi leaf decoction agar containing 3 per cent of glucose. Both the media were adjusted to pH varying from about 3 to 9 before inoculation. The following statement gives the results obtained:—

Average rate of growth per day in Czapek's and ragi decoction dextrose agars in mm.

Czapek's agar.		Ragi decoction agar.	
pH. value.	Daily growth.	pH. value.	Daily growth.
3.4	No growth.	3.8	9.7
4.5	6.0	5.0	11.3
5.5	8.0	6.0	11.3
6.4	8.7	7.0	9.7
7.5	7.3	8.0	10.7
..	..	8.8	10.7

The optimum pH for the growth of this organism is thus found to be between pH 5.0 and 6.4.

Change in the pH of the medium during the growth of the fungus.—Ragi leaf decoction plus 3 per cent dextrose adjusted to pH varying from 2.4 to 8.2 was inoculated with ragi *piricularia* and the change in pH was ascertained at intervals of five days. The following table gives the results obtained:—

Initial pH.	Change in pH after.		
	5 days.	10 days.	15 days.
2.4	..	No growth.	
3.2	..		
4.2	4.3	5.3	6.1
5.2	4.4	5.5	6.3
6.4	5.8	6.3	6.1
7.4	6.0	5.7	6.1
8.2	6.8	6.3	6.1
...	7.7	7.5	6.3

The table shows that there is always a tendency to shift towards a final reaction of about pH 6.0, whatever the initial pH might have been at the time of the inoculation.

Effect of temperature in relation to the growth of the fungus.—Petri dishes with ragi leaf decoction agar with 3 per cent glucose having an initial pH of 5.84 were inoculated with ragi *Piricularia*

and incubated at temperatures varying from 9.0°C to 32°C. The following table gives the average rate of growth obtained per day at the temperatures tried :—

Temperature.				Average rate of growth per day in mm.
9°C	..	..	..	No growth.
15.5°C	..	..	..	6.0
20.5°C	..	..	..	7.0
24.5°C	..	..	..	8.5
29.5°C	..	..	..	10.0
30.5°C	..	..	..	8.5
32.0°C	..	..	..	7.3

It will be seen from this that the optimum temperature for the growth is at about 29.5°C.

Thermal death point of the organism.—The thermal death point of conidia of ragi *Piricularia* was found to lie between 48° and 49°C for an exposure of five minutes.

9. Sugarcane—Red-rot—*Colletotrichum falcatum*.

The fungus was brought into pure culture from specimens obtained from a neighbouring village.

Varietal resistance.—The following eleven varieties of sugarcane were tested for their resistance to red-rot infection : (1) POJ 213, (2) POJ 2878, (3) POJ 2725, (4) Co 213, (5) Co 281, (6) Co 290, (7) Co 413, (8) Co 419, (9) Co 421, (10) Vellai and (11) Poovan. Setts of these varieties were inoculated and incubated. The fungus was found to spread equally well through the setts of all the varieties except Co 281 where only a very small area at the seat of inoculation was found infected.

Another experiment was tried with Vellai and POJ 213 to find out the spread of infection from the setts to the shoot. Setts of these varieties were inoculated and then planted in pots. Vellai was found to be susceptible as the infection passed rapidly from the sett to the shoot. In the case of POJ 213 however, the disease did not pass from the sett to the shoot even after three and a half months.

Change in pH of the medium during the growth of Colletotrichum falcatum.—When flasks with Richards' solution with an initial pH of 4.3 are inoculated with the fungus there is a progressive change in pH of the medium from 4.3 to 6.7 according to the age of the culture. The quantity of fungal growth increases in weight up to three weeks after which there is a reduction in weight due to autolysis.

Utilization of carbohydrates.—Seven sources of carbohydrates were used to find out the most suitable carbohydrate for the growth of the fungus. The following tabular statement gives the

weight of dry mycelial mats obtained in liquid media and the diameter of the colonies in agar media :—

Carbohydrate.			Weight of fungus in 18 days. mg.	Diameter of colonies in 12 days. mm.	Remarks.
Sucrose	..	..	323.4	80.0	Thick growth.
Glucose	..	..	143.5	56.3	Sparse growth.
Starch	..	..	17.4	71.8	Do.
Lactose	..	..	8.8	83.5	Do.
Maltose	..	..	11.5	41.8	Do.
Cellulose	..	..	..	..	Sparse growth on agar due to im- purities.
Arabinose	..	..	..	25.0	Slight growth.
No carbohydrate	..	No growth.	..	65.0	Very thin superfi- cial strands of growth in agar due to impuri- ties.

The results show that sucrose was the best for the growth of the fungus, glucose coming second. Iodine tests showed that starch was utilized only to a small extent. There was no growth on cellulose. The size of the spores was not affected.

Growth of the fungus with various sources of nitrogen.—Six sources of nitrogen were tried for the growth of the organism. The following table gives the diameter of the colonies obtained in agar media after a growth of seven days and the mean size of spores :—

Nitrogen source.				Diameter of colony in mm.	Mean length of spores, in μ .
Asparagin	..	..	..	45.8	24.4
Peptone	..	..	..	78.0	27.62
Pot. Nitrate	..	..	..	27.7	31.44
Amm. Sulphate	..	..	..	9.0	22.44
Urea	..	..	..	7.9	Not pro- duced.
Pot. Nitrite	..	..	..	No growth	..

Asparagin was found to be the best source of nitrogen for the growth of *C. falcatum*, peptone and potassium nitrate also giving good growth. The growth was poor in ammoniacal nitrogen and urea and there was no growth in nitrite. The size of the spore was also influenced by the source of nitrogen used.

Growth of the organism in relation to the carbon nitrogen ratio in the medium.—The influence of the carbon/nitrogen ratio on the growth of the fungus was ascertained by growing the fungus in liquid media with varying proportions of C and N and then estimating the dry weight of mycelial growth in each case. The highest weight was obtained in 5/1 and there was gradual diminution of growth as the proportion of carbon was diminished.

Growth in relation to temperatures.—The original isolation of the fungus as well as a lighter colored saltant obtained were grown in liquid media at temperatures varying from 5°C to 37.5°C. The dry weight of the growth in mgm. obtained at each temperature is given in the statement below :—

Strain of <i>C. falcatum</i> .	Temperature.						
	5°C	10°C	15°C	20°C	26.5°C	32.5°C	37.5°C
Dark strain ..	Nil	16.0	52.9	138.0	410.6	423.5	..
Light strain ..	Nil	15.7	80.2	129.2	196.5	214.6	5.5

The optimum temperature is found to be about 32.5°C, the minimum being 10°C and the maximum 37.5°C for both the strains.

The germination percentages of the spores at various temperatures are given in the following tabular statement :—

Temperature.	Percentage of germination.	Average tube length μ .
10°C	No germination	..
15°C	5	76.4
20°C	50	138.4
26°C	85	163.5
37°C	95	71.8

Inversion of cane juice by Colletotrichum falcatum.—The fungus was grown in sterilized cane juice and the amount of sucrose and glucose in inoculated and uninoculated cane juice was estimated. The results obtained are given below :—

	pH. value.	Per cent of glucose.	Per cent of sucrose.
Uninoculated control ..	4.7	1.64	16.27
Inoculated (seven days old) ..	6.1	6.52	11.21

This shows that there is an increase in the percentage of glucose due to the inversion of sucrose.

Enzymes.—Extracts were made from the ground mats of dry mycelium and tested for various enzymes. The presence of pectinase, invertase and small quantities of diastase, maltase and lactase were detected. Oxidase production was shown by the formation of dark halo round the growths in potato dextrose agar containing tannic acid.

10. Cotton—Seedling blight and boll rot.

Colletotrichum indicum.—This fungus was isolated from diseased cotton bolls obtained from Nagpur.

Parasitism.—Inoculations were tried on the following species and varieties of cotton :—

Cotton varieties.					Unwounded seedlings.	Bolls.	
						Wounded.	Unwounded.
<i>Gossypium herbaceum</i> types—							
1 H 1 ..	..	..	..	..	+	+	+
2 H 2919 ..	..	..	..	..	+	+	—
3 Dharwar ..	..	..	..	..	+	+	—
4 Kumpta wilt resistant ..	..	..	..	..	+	..	..
5 Jayawant ..	..	..	..	..	+	..	..

Cotton varieties.	Unwounded Seedlings.	Bolls.	
		Wounded.	Unwounded.
<i>G. arboreum</i> types.—			
6 K 1	+	—	—
7 Sanguineum	+	..	..
8 Bani	+	..	..
9 Cocanadas	+	+	+
10 N 14	+	..	..
11 Roseum	+	+	—
12 Poonam	+	..	..
13 Tellpathi	+	..	..
14 Parbhani	+	..	..
15 Verum	+	—	—
16 Nadam	+	+	—
17 Burma C 19	+	..	..
18 Cernuum	..	—	—
19 Abu Haneira	..	+	—
20 Nanking white	..	+	Slight.
21 Arboreum vedasanthur	..	Slight.	—
22 Hampi	+	..	..
<i>G. hirsutum</i> types.—			
23 Co 2	—	—	—
24 Bourbon	—	..	..
25 Moco	—	..	..
<i>G. barbadense</i> .—			
26 Sea Island	—	..	..
27 Quebra	—	..	..
28 Verdos	—	..	..
29 G. Stooksi	+	..	..
30 G. Arboreum ×	Some affected.	..	..
G. barbadense		..	..
<i>Other hosts</i> —			
31 Hibiscus esculentus	—	..	..
32 Allium cepa	—	..	..
33 Brassica oleracea var. Capitata	—	..	..
34 B. Oleracea var. caulorapa	—	..	..
35 Capsicum annum	—	+	—
36 Zingiber officinale leaves	..	+	—

(Suitable controls were kept in all cases and these remained healthy.)

In the case of those seedlings of cotton where successful infection was obtained, the infection took place only in young seedlings up to a fortnight old. Seedlings 26–30 days old were not affected. It was also found that all the varieties of Asiatic cottons tried were susceptible while the exotics were not affected. A hybrid (*carboreum* × *barbadense*) showed 25 per cent infection.

The parasitism of the fungus on bolls also is more on the *herbaceum* types than on others.

Cross inoculations with other genera of plants gave successful infection only in the case of wounded chilli fruits.

Seed and soil infection.—Delinted cotton seeds soaked in a spore suspension and sown in germination trays gave only 24 per cent germination while the control gave 80 per cent germination. When such inoculated seeds were sown in sterilized soil, the germination was again found to be reduced and the seedlings that came up were diseased indicating that infection could be carried through seed. Diseased seedlings were mixed with sterilized soil and sown with delinted healthy seeds. The seedlings that emerged were all found infected and died within ten days, thus indicating that infection was carried through the infected soil.

Progressive change in pH.—In modified Richards' solutions, the growth of this fungus produces a progressive change in pH from 4.7 to 7.9 in 32 days. The maximum weight of the growth was found on the twenty-third day after which there was reduction in weight due to autolysis.

Utilization of carbohydrates.—This was studied by measuring the diameter of the growth on solid media and also by determining the weight of growth in liquid media. The following table gives the results obtained :—

Carbon source.			Initial pH.	pH. value after 18 days.	Weight in mgm.	Diameter on 6th day in mm.
Sucrose	..	..	4.4	6.8	266.7	49.2
Glucose	..	..	4.3	7.3	223.3	49.3
Starch	..	..	7.2	4.6	188.4	45.5
Lactose	..	..	4.4	6.0	107.6	49.2
Maltose	..	..	4.4	7.3	270.9	57.2
Cellulose	..	..	4.4	5.4	Slight growth.	Slight growth.
No carbohydrate	..	..	4.6	4.6	No growth.	No growth.

The fungus grows well on sucrose, maltose, and glucose. Starch was found to be completely utilized when tested with iodine. It is also found capable of utilizing cellulose to a slight extent.

Nitrogen sources.—Six sources of nitrogen were used for this study. The results obtained are given in the table below :—

Nitrogen source.			Diameter of colonies in 9 days.	Mean spore length.
Peptone	..	..	60.8 mm.	27.72 μ
Asparagin	..	..	43.5 mm.	25.84 μ
Potassium nitrate	..	..	45.4 mm.	27.44 μ
Urea	..	..	32.5 mm.	27.32 μ
Ammonium sulphate	..	..	19.7 mm.	2.42 μ
Potassium nitrite	..	..	No growth.	..

The growth was good in asparagin, peptone and potassium nitrate with copious formation of acervuli. In urea the growth was poor and irregular but with good spore formation. In ammonium sulphate the growth was thick and irregular with few spores. On nitrite there was no growth.

Carbon/nitrogen ratio.—As in *Colletotrichum falcatum* in this case also there is reduction in growth as the proportion of carbon decreases.

Temperature relations.—The fungus was grown at different temperatures ranging from 5°C to 44°C in French bean and Quaker oats agars. The following statement gives the temperatures and the colony diameter obtained at each temperature :—

Medium.		5°C	10°C	15°C	20°C	32°C	37°C	44°C
French bean agar	..	No growth.	No growth.	mm. 26	mm. 58.5	mm. 73.7	mm. 54.25	No growth
Quaker oats agar	..	..	..	31.25	63.5	80	..	..

The optimum growth was found to be near 32°C. The spores in all cases were of the same average size. Inoculations of seedlings from spores from these cultures showed the same virulence

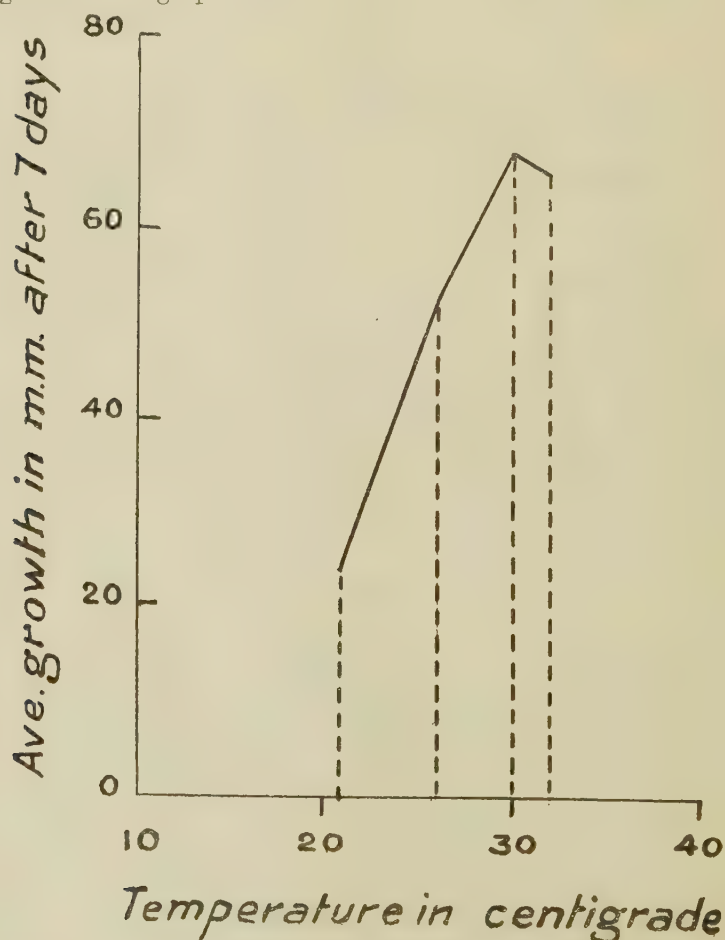
except those at 37°C which took six days more for killing the seedlings.

Enzymes.—Extracts of ground mycelial mats showed the presence of pectinase, diastase, invertase, lactase, maltase and oxidase.

Toxins.—Cotton seedlings eight days old were removed carefully by washing away the soil and placed in test tubes containing distilled water, Richards' solution and filtrate of *C. indicum* grown in Richards' solution. The two solutions were adjusted to the same pH before placing the seedlings. In 7 hours the cotyledons of seedlings in the filtrate became flaccid and in 22 hours the seedlings wilted whereas in the control and distilled water there was no sign of wilting, the seedlings being normal and turgid.

11. Betelvine wilt—*Phytophthora* sp.

Physiological studies—Relation between temperature and growth.—The relative growth of the fungus in malt agar under temperatures varying from 10°C to 37°C was studied. The results are given in the graph below :—



There was no growth at 10, 15 and 35°C. The optimum was found to be about 30°C.

Relative growth in media of different pH values.—The fungus was grown in Waksman's liquid medium adjusted to pH values varying from 4.0 to 8.0 and the dry weight of mycelial mat obtained after three weeks. Growth was poor in ranges below pH 5.5 and above 7.0, but within this range there was no significant difference in the weights obtained. The growth obtained on solid agar with various pH also showed that the optimum lay between 5.5 and 7.0.

Field experiments for control of the disease.—A field experiment was laid out in collaboration with the Assistant Director of Agriculture, St. Thomas Mount at Minjur (a village eighteen miles from Madras) to study the effects of various treatments on the incidence of disease. The experiment consisted of (1) soil treatments and (2) spraying.

The soil treatments consisted of the following applications :—

- (1) Sulphur at the rate of 500 lb. per acre.
- (2) Application of 1 per cent acid Bordeaux mixture at the rate of 3 gallons per 19 feet of ridge.
- (3) 0.1 per cent copper sulphate solution at the rate of 50 lb. of copper sulphate per acre.

The spraying consisted of three applications of 1 per cent Bordeaux mixture every year to the base of the vines from the time when the vines are about 6 months old. The results are awaited.

12. *Citrus leaf fall and fruit rot—Phytophthora sp.*

Field experiments for control.—The disease broke out in July 1938 in a virulent form in many of the orange plantations in Wynad causing considerable damage to the crop. The present experiment was therefore designed with a view to find out whether one spraying of Bordeaux mixture was sufficient to control the disease or two sprayings were necessary and also whether it is more advantageous to spray the trees before the onset of the monsoon than after the first appearance of the disease. The experiment has been laid out in a garden belonging to Sri Padma-prabha Gowda at Puliarmali Estate, Kalpatta, Wynad. The disease was reported to have caused considerable damage in this garden last year.

The following are the treatments :—

- (1) One premonsoon spraying with 1 per cent Bordeaux mixture with oil.
- (2) One spraying with 1 per cent Bordeaux mixture with oil after the first appearance of the disease.

(3) Two sprayings with 1 per cent Bordeaux mixture with oil the first spraying just before the outbreak of the monsoon and the second one just after the disease breaks out in the garden.

(4) Control.

Each unit of treatment consists of 15 trees and each treatment is repeated five times, involving a block of 300 trees. The experiment is under progress.

13. Ginger—Rhizome rot—*Pythium* spp:

Field experiments.—Two elaborate field experiments were laid out in Malabar during 1938 for the control of soft rot. Nine seed disinfection treatments with (formalin, Cheshunt compound, mercuric chloride, acidulated mercuric chloride, mercurous chloride, germisan, semesan, ceresan and cuprocide) and ten manurial treatments (Nicifos, super phosphate, lime, potash, super phosphate + potash, super phosphate + lime, potash plus lime, superphosphate plus potash plus lime, superphosphate + ammonium sulphate and bone meal). As there was no shoot rot in any of the plots, no figures could be obtained on the incidence of disease under various treatments. The harvest of the crop in plots under seed treatments however gave significantly higher yields in the case of mercuric chloride, mercurous chloride, germisan, semesan and ceresan. Observations have shown that the fungus *Pythium* can cause a root rot without producing the rhizome or shoot rot.

Experimental plots for the control of ginger soft rot were again laid out in 1939 in two different places in Malabar. The experiments consist of soil and seed treatments.

The soil treatment series consists of the following treatments :—

- | | |
|-----------|----------------|
| (1) K + N | (4) N + K + P |
| (2) N + P | (5) Quicklime. |
| (3) K + P | (6) Control. |

The seed treatment series consists of the following treatments :—

- | | |
|------------------------|------------------|
| (1) Mercuric chloride. | (4) Cuprocide. |
| (2) Semesan. | (5) Trichoderma. |
| (3) Ceresan. | (6) Control. |

Another experiment laid out to find out the best methods of preservation of seed ginger showed that treatment with mercuric

chloride 0.1 per cent was the best preservative as shown in the following tabular statement:—

Number and treatment.	Date of treatment.	Date of observation.	Original weight.	Final weight.	Weight of	
					Healthy seeds.	Dis-eased.
			LB.	LB.	LB.	LB.
1 Wood ash	10th January 1939	26th May 1939.	25	6	..	6
2 Mercuric chloride 0.1 per cent for 1½ hours.	Do.	Do.	25	25	25	..
3 Copper sulphate 1 per cent for 1 hour.	Do.	Do.	25	12½	4¼	8¼
4 Smoking for 4 months	Do.	Do.	25	6½	3½	3
5 No treatment	Do.	Do.	25	15½	7	8½
Do.	Do.	Do.	25	14½	6½	8

Biological antagonism.—The fungus *Trichoderma lignorum* was found to invade and suppress the colony of *Pythium* when grown side by side. Filtrate from *Trichoderma* liquid cultures added to nutrient agar also suppressed the growth of *Pythium*. Filtrate from 5-day old cultures only was found to inhibit growth of *Pythium* while filtrate from 10-day old cultures was ineffective. In mixed cultures of *Pythium* and *Trichoderma*, the latter was found to increase the acidity of the medium to such an extent that it was quite unfavourable to the growth of *Pythium*. This extreme acidity of the medium was not found when *Trichoderma* alone was cultured.

Over-wintering.—The fungus *Pythium* was found to persist in the soil in spite of rotation with paddy and was found to be viable in the organic matter of air dried soil even after a year.

Thermal death point of ginger *Pythium* was found to lie between 48°C and 50°C when exposed for five minutes.

14. Chillies—Fruit rot—*Colletotrichum capsici*.

This fungus was isolated from specimens received from Taliparamba. Inoculations were made with this fungus on chilli fruits and cotton seedlings. There is no infection on cotton while unwounded chillie fruits are readily infected.

15. Citrus mottle leaf.

Zinc sulphate spraying was found to be quite successful in improving the condition of affected trees. The remedy was applied successfully to the following species of citrus.—*C. nobilis* (Nagpur Santhra), *C. sinensis* (Kodur Cheeni and Batavian orange), and *C. decumana* (Pomelo).

16. Coconut bleeding disease—*Thielaviopsis paradoxa*.

The fungus was isolated from specimens received from the coconut research station. Inoculations carried out on coconut seedlings show that wounded seedlings are readily infected.

17. *Cardamoms.*

Specimens of rhizome rot received from three different localities were associated with three different fungi, viz., *Cephalosporium* sp., *Pythium complectens* and *Rhizoctonia bataticola*. *Pythium complectens* is also found to infect ginger when inoculated and has also been isolated from infected rhizomes in the field.

II. VIRUS DISEASES.

1. *Sugarcane—Mosaic—Varietal resistance trials.*—The annual field trials to estimate the relative resistance to mosaic were continued. Nineteen varieties of sugarcane were included in the trial. The following tabular statement gives the varieties tested from 1933-34 :—

Sugarcane Mosaic—Varietal resistance trials
1933-34 to 1938-39.

Serial number and varieties tested.	Number of years under trial from 1933.	Percentage of infection.					
		1933-34.	1934-35.	1935-36.	1936-37.	1937-38.	1938-39.
1 Co. 205 Pusa ..	6	Nil.	N 1.	Nil.	Nil.	Nil.	Nil.
2 Co. 213 ..	6	95.0	95.0	63.5	70.0	86.0	82.0
3 Co. 360 ..	6	73.0	81.5	55.4	56.0	67.0	73.0
4 Co. 361 ..	6	70.0	55.5	53.4	40.0	78.0	59.0
5 Co. 335 ..	5	Nil.	Nil.	Nil.	Nil.	Nil.	..
6 Co. 355 ..	4	..	Nil.	Nil.	Nil.	Nil.	..
7 POJ. 2878 ..	4	Nil.	N 1.	Nil.	Nil.	..	..
8 Co. 363 ..	3	39.0	17.0	11.4	..	..	..
9 Co. 402 ..	3	7.5	13.0	13.4	..	..	..
10 Co. 408 ..	3	31.0	13.5	37.5	..	..	..
11 Co. 412 ..	3	8.5	10.5	7.2	..	..	..
12 Co. 407 ..	3	..	..	..	8.0	37.0	28.0
13 Co. 434 ..	3	..	..	..	Nil.	Nil.	Nil.
14 Co. 205 ..	2	Nil.	Nil.	..	..	..	..
15 Co. 353 ..	2	..	..	5.4	Nil.	..	..
16 Co. 354 ..	2	..	55.0	55.0	..	..	..
17 Co. 411 ..	2	..	4.0	1.9	..	..	..
18 Co. 413 ..	2	..	4.0	Nil.	..	..	..
19 Co. 415 ..	2	..	..	..	..	10.5	12.3
20 Co. 417 ..	2	..	49.0	43.5	..	..	..
21 Co. 419 ..	2	..	43.0	43.6	..	..	..
22 Co. 511 ..	2	..	..	..	..	Nil.	Nil.
23 Uba ..	2	..	..	..	Nil.	2.0	..
24 B. 3412 ..	1	70.0	..	..	..	..	..
25 E K. 28 ..	1	85.5	..	..	..	..	..
26 Poovan ..	1	62.5	..	..	..	..	..
27 Vellai ..	1	79.5	..	..	..	..	..
28 Pund a ..	1	..	..	25.6	..	..	..
29 Co. 229 ..	1	..	..	Nil.	..	..	..
30 Co. 313 ..	1	..	..	63.4	..	..	..
31 Co. 326 ..	1	..	..	Nil.	..	..	..
32 Co. 331 ..	1	..	..	38.0	..	..	..
33 Co. 352 ..	1	..	..	..	Nil.	..	..
34 Co. 356 ..	1	..	..	Nil.	..	..	..
35 Co. 364 ..	1	..	..	..	..	44.0	..
36 Co. 404 ..	1	..	..	..	..	49.0	..
37 Co. 414 ..	1	..	..	..	..	62.0	..

Serial number and varieties tested.	Number of years under trial from 1933.	Percent age of infection.					
		1933-34.	1934-35.	1935-36.	1936-37.	1937-38.	1938-39.
38 Co. 416	1	..	..	..	62.0	..	..
39 Co. 421	1	..	..	24.3	..	..	..
40 Co. 422	1	..	..	..	Nil.	..	..
41 Co. 423	1	..	..	..	70.0	..	..
42 Co. 426	1	..	..	43.1	..	..	..
43 Co. 429	1	..	..	39.9	..	..	..
44 Co. 432	1	..	..	..	18.0	..	..
45 Co. 433	1	..	..	..	..	45.5	..
46 Co. 438	1	..	..	..	23.0	..	..
47 Co. 508	1	..	..	Nil.	..	..	..
48 Co. 513	1	..	..	..	..	66.0	..
49 Co. 520	1	..	..	..	..	36.0	..
50 Co. 428	1	..	..	..	..	..	73.0
51 Co. 436	1	..	..	..	..	..	56.0
52 Co. 439	1	..	..	..	..	..	32.0
53 Co. 440	1	..	..	..	..	..	57.0
54 Co. 441	1	..	..	..	..	..	60.0
55 Co. 442	1	..	..	..	..	..	54.0
56 Co. 443	1	..	..	..	..	..	6.0
57 Co. 444	1	..	..	..	..	..	88.0
58 Co. 445	1	..	..	..	..	..	70.0
59 Uba A	1	..	..	..	..	..	Nil.
60 Uba B	1	..	..	..	..	..	4.0

Co. 205 continued to show resistance as in previous years. Co. 434, Co. 511 and Uba A remained free throughout. Co. 434 has been under trial for a period of three years and has consistently shown a high degree of resistance. Co 511 has been under trial for two years and has also proved resistant.

2. *Cardamom mosaic*.—The disease was found to be very severe in many plantations in the Anamalais but was not found to be present in the Nelliampathies.

Transmission experiments.—Trials under controlled conditions with thrips from infected plants both in the Anamalais and at Coonoor, failed to transmit the infection to healthy cardamoms. Sap inoculations also failed to transmit the disease. Suspicious cases of successful transmission were obtained at Coimbatore when viriferous thrips from cardamoms were transferred to ginger plants.

3. *Tobacco mosaic*.—Two strains of mosaic different from the strains noticed previously were obtained. One of these mosaics shows mottling consisting of large green blotches without general puckering of the leaves. The disease is found transmissible to *Nicotiana glutinosa* but does not cause local lesions. The disease produces mottling symptoms on both the dark and white varieties of *Datura fastuosa*.

The other strains of tobacco mosaic were found to be not transmissible to both the varieties of *D. fastuosa*.

A strain of mosaic obtained from tomato was found transferable to tobacco, *N. glutinosa* and *D. fastuosa*. A strain of mosaic

obtained from *Datura* was found to be transferrable to *N. glutinosa* causing local lesions and *N. tabacum*. The mosaic caused puckering and reduction of the lamina of the leaves.

There are thus five strains which appear to be different from each other :—

- (1) Tobacco mosaic transferrable to *N. glutinosa* causing local lesions.
- (2) Tobacco mosaic causing mottling in *N. glutinosa*.
- (3) Tobacco mosaic not transferrable to *N. glutinosa*.
- (4) *Datura* mosaic causing local lesion in *N. glutinosa*.
- (5) Tomato mosaic causing mottling in *N. glutinosa*.

A hybrid *N. glutinosa* × *N. tabacum* (Harrison's spl.) behaved similar to *N. glutinosa* in its reactions and was found to be sterile.

4. *Brinjal little leaf*.—The investigation was pursued in detail with special attention on the following aspects :—Varietal resistance, host range and transmissibility.

Varietal resistance.—Thirty-six varieties were tested for their resistance under natural conditions. All the varieties tried were found susceptible to the disease.

Host range.—The disease was successfully transmitted to tomato, tobacco, *Datura fastuosa*, *Solanum xanthocarpum*, *S. torvum*, *S. trilobatum* and a wild variety of *S. melongena* by grafting. In all cases the characteristic symptoms of reduction in the size of the leaves, stimulation of axillary buds, malformation of flowers and sterility were reproduced.

Insect transmission.—After unsuccessful trials with various sucking insects, a number of successful transmission results were obtained with a jassid (*Eutettix phycitis*) as vector. The insect has so far not been recorded on brinjal in South India. It is found feeding on the following plants in nature (1) *S. melongena*, (2) *D. fastuosa*, (3) *S. xanthocarpum*. It breeds freely on brinjal and *Datura*.

Another jassid (*Empoasca devastans*) gave a few cases of successful transmission but the results were not so consistent as in the case of *E. phycitis*.

Papaya leaf curl.—A hitherto unrecorded disease was noticed on a few plants this year. The disease is characterised by puckering and curling of leaves which bend inwards in cup-like formations. The veins get thickened and gnarled with slight greenish outgrowths. The disease was found transmissible to healthy papaya plants by grafting.

III. ADVISORY WORK.

One hundred and thirty-six specimens of diseased plants were received for examination and technical advice. Besides these several enquiries relating to plant pathological problems were dealt with.

IV. QUARANTINE SERVICE.

Fifty consignments of plants and seeds were examined or fumigated and samples from seventy-one consignments of tamarind meant for export to Egypt were examined and necessary certificates issued.

V. LEGISLATIVE MEASURES AND THEIR WORKING.

1. The Agricultural Pests and Diseases Act of 1919 was extended for a period of one year in respect of the bud-rot disease of palmyra and coconut palms in Palghat, Walluvanad and Ponnani taluks of Malabar. A sub-assistant in Mycology, a Mycology Demonstrator and a Special Revenue Inspector continued to be in charge of the special work. It is still very unfortunate that the reports sent by the village officers give only about 50 per cent of the infected trees as is evidenced by the fact that the departmental officers have been able to find nearly an equal number of cases besides those given in the lists furnished by the village officers.

It is too early to say about the success of the work in Walluvanad and Ponnani taluks. However, as far as the Palghat taluk is concerned where the Act has been in force for about six years, there has been a gradual decline in the number of trees cut every year as shown in the statement below:—

Year.	Number of infected trees cut.		
1933-34	..	..	10,800
193 -35	..	..	6,900
1935-33	..	..	6,450
1936-37	..	..	2,477
1937-38	..	..	1,738
1933-39	..	..	1,848 (for fifteen months).

As a result of the enforcement of the Pest Act, it is seen that cases of infection are becoming less and less every year on account of reduction in the sources of infection by destroying the affected trees.

A special staff has also been appointed during the year to tackle with the extensive spread of bud-rot of palmyra palms in parts of Kovvur, Tanuku, Narsapur, Pithapur, Cocanada, Ramachandrapur and Razole taluks.

2. *Application of Legislative measures for protection of cardamom plantations in Nelliampathies.*—On the representation of the Nelliampathy Planters' Association requesting legislation to prevent the entry of mosaic disease of cardamoms into the Nelliampathy planting district two surveys were made of the cardamom estates in the district. Since the district was found to

be free from this specific disease and forms a zone isolated from infected districts, steps were taken to pass a legislation to prevent the import into the district of living planting material other than true seed. The area known as Nelliampathies being situated partly in British India and partly in the Cochin State, steps were taken for conjoint action.

VI. PROPAGANDA.

1. *Areca mahali control*.—The areca spraying experimental plots in South Kanara were of much use in spreading the knowledge necessary for successful control of *mahali*. The fieldman stationed there to look after the experiments visited several centres and made himself useful to the neighbouring villages. The Collector of South Kanara visited the experimental garden and complimented the section about the very useful work done there.

2. *Propaganda through exhibitions*.—Mycological exhibits consisting of posters, charts and specimens formed a prominent feature in the following exhibitions during the year :—

- (1) Agricultural exhibition at Tiruppur during the cattle show.
- (2) Agricultural Exhibition during the college Day and conference at Coimbatore.
- (3) All-India Khadi and Swadeshi Exhibition and the Park Fair Exhibition at Madras.
- (4) Cudappah District Agricultural Exhibition.
- (5) Mahasivarathri Exhibition at Pedda Kallapalle.
- (6) All-India Swadeshi Exhibition, Coimbatore.
- (7) The Commercial Museum, Mangalore.
- (8) Panagal Demonstration Farm, Kalahasti.

3. *Press propaganda*.—Two press notes on the *mahali* disease of arecanuts were published, advising the ryots to take to spraying sufficiently early so that the disease is checked completely.

4. *Propaganda through radio*.—A popular talk in Tamil on the diseases of paddy was broadcasted through the station at Trichinopoly.

VII. TEACHING.

Consequent on the amalgamation of teaching and research, the work of teaching the subject of mycology was taken up from the 1st August 1939. Twenty-six lectures were delivered and 22 practical classes conducted for B.Sc. Ag. final year students. A course of 17 classes of 48 hours total duration was held on plant diseases and their control for the short course students. A revised syllabus in plant pathology was prepared and submitted to the Board of Studies in Agriculture.

Messrs. V. Thirumala Rao and M. S. Subbiah, Assistants in Entomology, were given training in mycology for three months. Sri C. Krishnamurthi, Entomology Assistant, is undergoing training from 7th June 1939.

VIII. MICROTOMY.

The microtome section continued to serve the needs of several workers both in the institute and in the districts. The following figures give an idea of the work done in the section:—

Materials received	558
Materials embedded	701
Number of blocks cut	321
Number of slides prepared	1,744
Number of slides stained	1,571
Number of slides mounted	1,549

Dr. P. J. Gregory, Research fellow of the Madras University, was working in the microtome section till 14th September 1938.

PUBLICATIONS.

1. A note on "Diseases of some important vegetable and fruit crops and their control" for "Gardening in Jails and Schools."

2. A note entitled "Plant pathology" for "Madras looks ahead."

3. Diseases of grape vine for the bulletin on "Cultivation of grape vine."

4. "The little leaf of Brinjal—a transmissible disease"—*Proceedings of the Indian Academy of Sciences*.

5. "Leaf crinkle—a transmissible disease of papaya" *Current Science*.

6. Some aspects on the control of mahali of the areca palm caused by *Phytophthora arecae*—*Madras Agricultural Journal*.

7. "Virus diseases of plants"—*Madras Agricultural Journal*.

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COIMBATORE,
5th August 1939,

K. M. THOMAS,
Government Mycologist.

